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NASA Technical Memorandum 78748

(NASA-TM-78748) ADAPTATION OF TIME LINE
ANALYSIS PROGRAM TO SINGLE PILOT INSTRUMENT
FLIGHT RESEARCH (NASA) 41 P HC A03/MF A01
CSCL 05H

N78-33731

Unclas
G3/53 33832

ADAPTATION OF TIME LINE ANALYSIS PROGRAM TO SINGLE PILOT INSTRUMENT FLIGHT RESEARCH

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AUGUST 1978



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Space Administration

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ADAPTATION OF TIME LINE ANALYSIS PROGRAM TO SINGLE PILOT INSTRUMENT FLIGHT RESEARCH

by

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SUMMARY

The time line analysis program, having been developed for the National Aeronautics and Space Administration (NASA) terminal configured vehicle program by the Boeing Company, has been adapted for general aviation single pilot instrument flight research. The objective of the research is to increase the safety and utility of general aviation aircraft by reducing the workload of the single pilot crew.

A human factors data base was developed for the program, the data was coded and stored as computer files, and the program was run.

The outputs indicated that further work was necessary on the workload models. In particular, the workload model for the cognitive channel must be modified as the output workload appears to be too small. Also, in need of modification is the left hand, right hand, left foot, and right foot channels.

Since the mission used in the first runs was simplified, refinements will be needed. Included in the needed refinements are models to show the workload when in turbulence, when overshooting a radial or glideslope, and when copying air traffic control clearances.

INTRODUCTION

NASA Langley has initiated the General Aviation Single-Pilot Instrument Flight Rules (GA-SPIFR) program to study the problems of a single pilot flying general aviation aircraft under instrument flight rules. It is anticipated that the number of instrument flight rules (IFR) accidents can be reduced and the utility of general aviation aircraft significantly increased by reducing the high workloads experienced in single pilot IFR operations. Statistical accident and incident data, a time motion computer program, a general aviation simulator, and aircraft flight tests will be utilized in analyzing and reducing pilot workload.

This report will discuss the development of the time motion computer program for the general aviation SPIFR study. The parent program was developed by the Boeing Company, Seattle, Washington, for the NASA Terminal Configured Vehicle program and is referred to as the Time Line Analysis (TLA),

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reference 1. The TLA is a time-motion study of a flight crew's activities and workload during a mission. An analyst must define the mission and a data base of activities to support it. From this data the TLA produces a series of digital and graphic reports describing the crew's workload during the mission. The baseline mission was defined as a single pilot instrument flight departing and returning to the William B. Hartsfield International Airport in Atlanta, Georgia. Radio navigation, a holding pattern, radar vectors, and an instrument landing system approach were included in the mission. The mission was highly idealized and assumed no clearance copying, no turbulence, and that all tasks were performed correctly and without repetition such as intercepts of very high frequency omnirange (VOR) radials and localizer and glideslope paths.

The mission was broken down into phases. These phases included segments of the flight from takeoff through landing.

From the maneuvers required of the aircraft, air traffic control procedures, and aircraft operating checklists, a set of procedures was developed. Procedures were written for such short term activities as flight control and equipment operations.

Procedures are made up of tasks. A task is the most basic action a pilot may perform. Reading the altimeter and moving the throttle are examples of a task. Checklists, procedures, and the cockpit layout of the general aviation aircraft simulator at the Langley Research Center were studied so that no detail of the operation of the aircraft would be omitted. The spatial position of each control, indicator, or instrument in the cockpit was measured relative to a nominal eye and shoulder reference point. Task duration times were determined from pilot's reach distances and eye angles which were calculated from position data.

The mission, phase, procedure, and task data were coded on the forms described in the Time Line Analysis User's Guide (reference 2) and stored as a computer file in the NASA CDC computing system. The program data were submitted as a batch job and digital graphic reports of pilot workload were obtained.

ACKNOWLEDGEMENT

The authors wish to acknowledge the assistance of Mr. James L. Sundstrom of the Boeing Company. Mr. Sundstrom has provided valuable guidance in the development of the mission data base and in the operation of the program.

ABBREVIATIONS

ATA	Airline Transport Association
ATC	Air traffic control
CDC	Control data Cyber 175 computer
CWP	Crewman workload profile report

GA-SPIFR	General Aviation single-pilot instrument flight rules
IFR	Instrument flight rules
MSN	Mission scenario report
TLA	Time Line Analysis
VOR	Very high frequency omnirange
WLH	Workload histogram report

ANALYSIS

Data Base Development

The first step in the use of the time line analysis program (TLA) was the development of a data base. The data base consists of phases, procedures, tasks, and subsystems necessary to describe the detailed flight operations required to accomplish the mission.

Mission.- The mission is the flight to be studied. In the example for this report the mission consists of a takeoff at the William B. Hartsfield International Airport in Atlanta, Georgia, an instrument climbout, very high frequency omnirange (VOR) navigation to a holding pattern, holding, air traffic control (ATC) radar vectors to an instrument landing system approach course, an approach, and a landing (figure 1).

Since the mission was built around an existing geographical area, the flight path was plotted on a chart for visualization and planning. Attention was given to ATC procedures, normal traffic routing, and aircraft operating capabilities.

Phases.- Once the mission was defined it was divided into phases. A phase of flight reflects the actions necessary to get from one flight milestone to another. The phases of the GA mission are takeoff, climbout, cruise, holding, initial approach, intermediate approach, final approach to the outer marker, final approach between the outer marker and middle marker, final approach between the middle marker and the runway, and touchdown. Using distances measured from the plotted mission and known aircraft performance data, the start time relative to the beginning of the mission for each phase was calculated. These start times are later used as guides when precisely defining the time structure of the mission. Since many of the output reports can be generated for only the phases specified in the output request, the breakdown of the flight into phases permits close study of a phase and comparisons between phases. Also, the breakdown provides a modular data base and simplifies changes to the mission.

Procedures.- A set of procedures was developed to support the phases. A procedure is a short duration activity such as a complete instrument scan or receiving and responding to a traffic advisory. In addition to ATC procedures, all required aircraft maneuvers, aircraft operating procedures, and the aircraft operating checklists were taken into account when writing procedures. The procedures were made as general as possible so as to minimize the total

number of procedures required. Instead of a specific procedure for entering a left turn or for receiving a handoff from departure control, for example, a procedure for receiving a handoff or executing a turn was designed. Also, all procedures assume that all tasks are accomplished when necessary and correctly the first time. This is not realistic; however, the idea was to begin with a simplified mission for baseline and to add refinements later.

Tasks.- A task is the simplest unit of work that the pilot can accomplish, such as reading the airspeed indicator or picking up the microphone. Development of the task data base began with the measurement of the position of every item in the NASA Langley general aviation aircraft simulator. The measurements were in the cartesian coordinate system shown in figure 2 and located with respect to the center of the attitude indicator. Every position that the pilot might look at for information or reach to was measured. For instruments that give information in several locations each location was measured. For example, the location of the center of the altimeter, the kolisman window, and the setting knob were all measured. From these measurements the eye angles and reach distances to each item were calculated. The eye angles were calculated with respect to the center of the attitude indicator, the left hand reach distances were from the left side of the control wheel centered in pitch and roll, and the right hand reach distances were from the throttle at its half open position.

Each item in the cockpit was grouped into subsystems. Examples of subsystems include electrical, engine, fuel, and trim. Pilot vision, voice, audio, and charts/checklists were listed as subsystems as were the cockpit items. The program requires that each task be associated with a subsystem and can provide reports on the activity of a particular subsystem.

From the list of the cockpit items, checklists, ATC procedures, aircraft operating procedures, and aircraft maneuvers, a task list was developed. Each task was assigned a subsystem, a code number, and a duration time, and the percentage of that duration time that impacted external vision, internal vision, left hand, right hand, left foot, right foot, cognitive, audio, and verbal human operator channels. Tasks, like procedures, were made as general as possible. Instead of three separate tasks for moving the transponder switch to off, standby, and on, for instance, one task was written to show movement of the transponder switch. Depending on the situation, a task may require different times or percentages. To account for this up to four different times or percentages can be assigned to each task. The duration times were calculated from the eye angles, reach distances, and human factors data supplied in reference 1, section 6.4. For tasks that were not covered by the human factors data such as radio communications, the duration time was estimated or timed with a stopwatch.

The value of the cognitive channel was assumed to be ten percent for each task. This was done with the knowledge that it was not realistic; however, the data necessary for determining cognitive workload is not currently available. As stated earlier, the intent was to make the program operational and to add refinements as data becomes available. Once the tasks were defined it was possible to determine the time structure of the procedures. The TLA worksheet shown in figure 3 is used for this purpose. The tasks and their

situation numbers and duration times are listed in chronological order. Tasks which occurred during the same time interval were listed near each other. The task start times are relative to the beginning of the procedure.

After the procedures were completed in detail, the time structure of the phases could be determined. The same worksheet used to define the procedures, shown in figure 3, was used to define the phases. All procedure start times are relative to the beginning of the phases. The procedure duration times are calculated to the nearest tenth of a second but the computer program will accept procedure start times to only the nearest second. In determining procedure start times for this mission, therefore, any previous noninteger procedure duration times were rounded to the next higher integer. This tends to artificially lower the overall workload of the pilot by a small amount; however, this avoids workloads exceeding one-hundred percent due to unintentional task overlapping. In this manner, output workload peaks of over one hundred percent will always be due to actual overloads and not due to periodic task overlapping. With the knowledge that the output workload is less than actual, output workloads near one hundred percent can be examined as possible overloads.

The phase start times calculated earlier from the flight path plot were only guides and are used here. If the original time calculations called for the pilot to maintain straight and level flight for two minutes then enough straight and level procedures would be used to total two minutes as nearly as possible.

Events were inserted into the phases along with the procedures to describe a flight milestone such as takeoff, level off at altitude, cross an intersection, enter a holding pattern, and intercept an ILS localizer. Events are used only as markers in the mission and do not contribute to workload. There are no tasks associated with events.

Having determined the exact duration times of the phases, the start times of the phases were calculated. Once the phases were completed and their start times determined, the mission development is finished and the data base is ready to be coded.

Data Base Coding

The data base coding forms are described in reference 1 and 2.

Figure 4 shows the subsystem coding form for this scenario. The Airline Transport Association (ATA) code number required for the original application of the program is not applicable to the GA research, therefore, the ATA code number column was left blank.

The task data coding forms were completed according to the instructions in reference 2. Occasionally, two tasks are used together. Columns 75-80 were used to refer to the accompanying task in these cases. On the example form in figure 5, 1A0131 refers to subsystem 1A, task 13, situation 1. A leading zero is placed before the 13 to produce a six character code.

A sample event/procedure data coding form is shown in figure 6. The alpha characters in the code numbers were used to refer to communications (C), communications radios (CR), manual flight control (F), navigation (N), navigation radios (NR), and miscellaneous systems (S). The slide interval columns were left blank since the task sliding option of the program, described in reference 1 and 2 was not used.

Figure 7 shows a completed phase data coding form. These forms were completed as specified in reference 2.

The mission data coding form was completed as shown in figure 8. The study time interval, an analyst defined time increment, was set at 20 seconds. The task sliding option referred to above was not used in this study. Therefore, the slide interval was set at one second and the slide workload threshold at 999 percent as suggested in reference 2.

Once coded, the data base was stored as a computer file. The data base forms were keypunched along with the control cards. Figure 9 shows the deck arrangement for the control cards and data cards. The phases, events, procedures, tasks, and subsystems, were stored under the file name GADBAZ shown in the appendix. The control cards, mission data, and output requests were stored under the file name TLATST. The object program was supplied by the Boeing Company under contract number NAS1-13741 and was stored under the file name TLABN3. The data are stored with a batch job under the DUMMY file by using the deck shown in figure 10 and the name is later changed with the use of a timesharing terminal. Placing the mission data and the output requests in file TLATST permits changing the study time interval, run data, and output requests and submitting the program without accessing the data base.

The data were stored in a logical order so that modifications to the data could be made easily. Procedures were grouped according to type and tasks were grouped by subsystems. During the development and coding of the data, unanticipated procedures and tasks were occasionally required and were added to the data base. After storage these additions and modifications were made via a timeshared terminal.

Program Operation

The program is submitted with the file TLATST. It is submitted as a batch job through the use of a timesharing terminal. A listing of TLATST is shown in figure 11. In use TLATST copies to data the input mission data, then the data base (GADBAZ), and then the process card, output request, and the terminate card. This assembles the program data deck into the form shown in figure 9.

The first runs were made for data base debugging. If the output channel workload exceeds 100 percent, errors in the data base or overloads are indicated. The tasks contributing to high workloads can be found with the workload histogram report (WLH), the crewman workload profile report (CWP), and the mission scenario report (MSN). References 1 and 2 describe each of the outputs. Approximate times of high workload peaks can be determined from the time scale on the WLH. Then the exact time interval of the occurrence can be

determined from the CWP by scanning down the workload column for the channel involved. After finding the time interval, the MSN is used to determine the tasks occurring during the interval. The errors included data artifacts such as misspecified start times, duration times, and situation numbers.

Only the CWP, MSN, and the WLH were seen for use in analysis. The outputs were validated with hand calculations of pilot workload at random points in the mission.

Figure 12 shows one page of the crewman workload profile report. The external vision is at zero percent and the internal vision is highly used due to the assumption of actual instrument conditions during the mission. Left hand activity is low but reasonably steady while right hand activity varies considerably and is usually high when being used. This is because the left hand is being used for the continuous tasks of maintaining straight and level flight in smooth air and the right hand is being used for discrete tasks such as tuning radios or handling the microphone. The left and right foot have identical workloads as they are always used together in the mission. Cognition levels are low and steady. This does not appear to be realistic and indicates that cognition has not yet been properly modeled. The audio and verbal channels indicate ATC communications.

Figure 13 shows a portion of the mission scenario report for the time interval covered in the crewman workload profile report shown in figure 12. The MSN is used to determine what tasks are occurring during any time interval. Together with the CWP, the MSN is useful in determining which tasks are contributing to high workloads.

The external vision WLH is shown in figure 14. External vision is only used during takeoff, landing, and during ATC traffic advisories.

Figure 15 shows the internal vision WLH. This is normally high but falls off during takeoff, landing, and ATC communications. The internal vision decreases during communications because the instrument scan falls off.

A WLH for the left hand is shown in figure 16. The large peaks are caused by such maneuvers as leveling off from a climb and executing turns. Continuous straight and level flight occurs in the areas where the plot is relatively flat. A somewhat higher workload is indicated during the approach and landing beginning at approximately 2200 seconds into the run.

The plot for the right hand, shown in figure 17, illustrates the intermittent usage of the right hand. The right hand is primarily used for the throttle, trim, radios, microphone, charts, and checklists. All other times it is assumed to be at rest or zero percent workload.

Figure 18 shows the left foot plot. Since the left foot and right foot workloads are identical, only the left foot plot is shown. As with the left hand, a higher workload is indicated during turns and final approach. The left and right foot workload model will need modification as the workload should be nearly zero during straight and level flight.

Figure 19 and 20 show the auditory and verbal channel plots, respectively. These plots primarily indicate ATC communications. In addition to communications, the auditory channel is used to check the morse code identification of radio navigational aids and to listen to the marker beacon signal during approach.

The cognitive plot is shown in figure 21. From the plot it can be seen that the ten percent cognition value per task was not realistic and that the cognition workload model will need extensive modifications.

CONCLUDING REMARKS

The time line analysis program, having been developed for the National Aeronautics and Space Administration (NASA) terminal configured vehicle program by the Boeing Company, has been adapted for general aviation single pilot instrument flight research (SPIFR).

A data base was developed for SPIFR operation, and the program was run.

The outputs indicated that further work was necessary on the workload models. In particular, the workload model for the cognitive channel should be modified as the output workload appears to be too small. More data are necessary to develop a cognitive channel workload model. Also, in need of modification is the left hand, right hand, left foot, and right foot channels.

Since the mission used in the first runs was simplified, refinements are needed. Included in the needed refinements are models to show the workload when in turbulence, when overshooting a radial or glideslope, and when copying air traffic control clearances.

REFERENCES

1. Miller, K. H: Time Line Analysis Program (TLA-1) Final Report. Boeing Document No. D6-42377-5. NASA CR-144942, April 1976.
2. Anderson, C. F.: Time Line Analysis Program (TLA) User's Guide. Boeing Document No. D6-44751. Published February 10, 1978, for period February 1976 - October 1977.

APPENDIX

GADBAZ, The Time Line Analysis Data File

Figure 22 shows the data base as stored in the computer file GADBAZ. The format of the data base results from the use of the coding forms described in references 1 and 2.

Figure 22-a shows the phase portion of the data file. The first phase, TAKEOFF RWY 8, consists of the code number T001, the phase name, EVENT1 beginning at time zero, procedure F00001 beginning at time zero, and procedure F00002 beginning zero minutes and 20 seconds into the phase. Procedures do not have to be listed in chronological order but doing so makes it easier to read the data.

The event/procedure data is shown in figure 22-b. By observing the column designations on the coding form in figure 6, it can be seen that the first two tasks of the first procedure, CONTACT DEP. AFTER TAKEOFF, are 1P 01 and 1P 07. 1P 01 begins at zero seconds into the procedure and P1 refers to the crew member performing the task (pilot) and the task situation number.

The task data is shown in figure 22-c. Figure 5 shows the column designations of the coding form. The first task, MOVE AUD. PNL. MIKE SWITCH, has the code number 1A 01, had only one situation, and has channel workloads of 40 percent interval vision, 100 percent right hand, and 10 percent cognition.

The subsystem data is shown in figure 22-d. The first subsystem listed has the code 1A and is named COM #1.

[illegible]

Figure 1.- Mission scenario plot. (not for navigational purposes; additions and deletions have been made to this chart)

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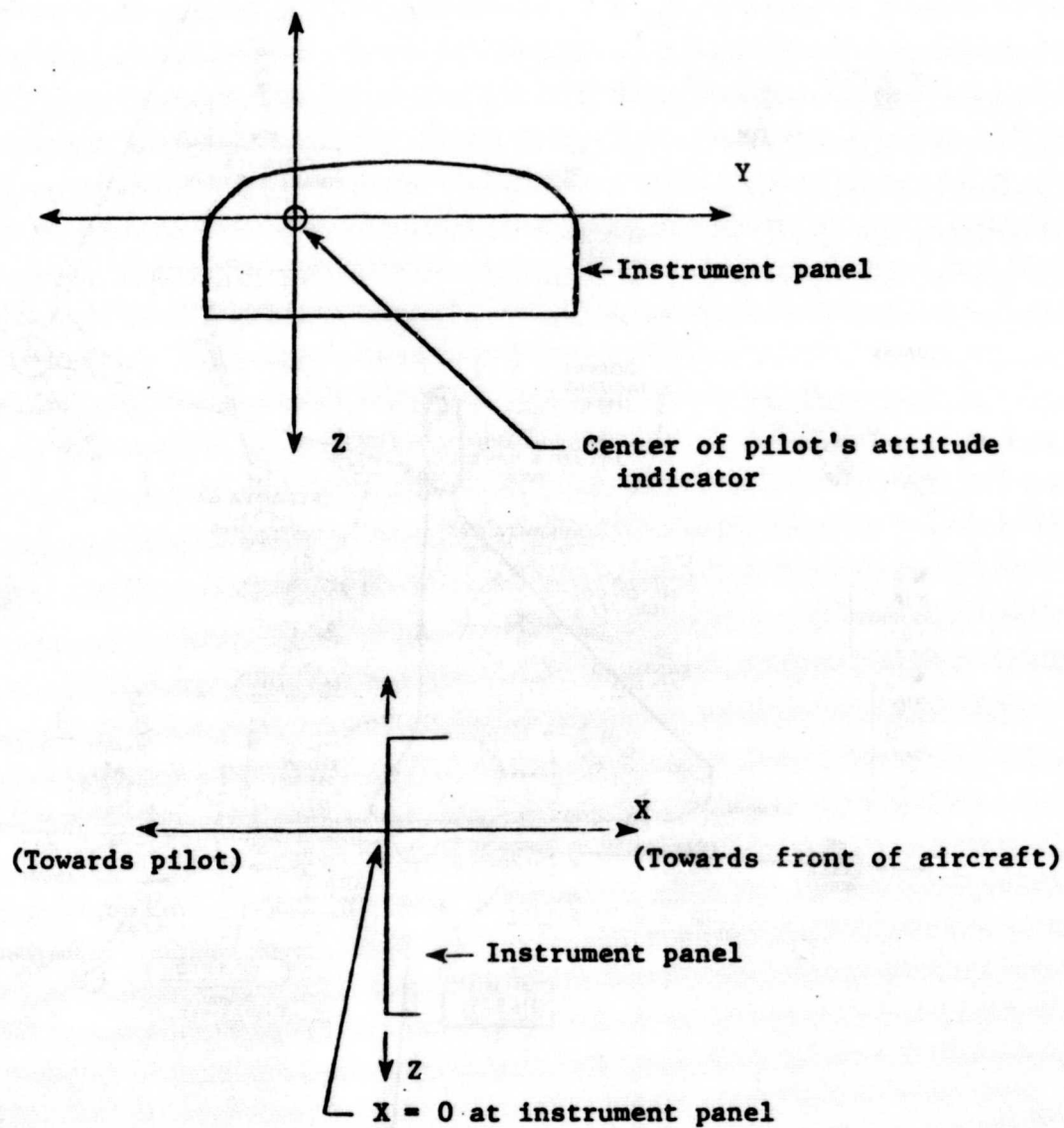


Figure 2.- Coordinate system in general aviation simulator.

TLA WORKLOAD ANALYSIS WORKSHEET

PAGE 08 OF

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MISSION TITLE		PHASE/EVENT/PROCEDURE DATA		PROCEDURE/TASK DATA							CONFIGURATION	
CODE NO.	NAME/DESCRIPTION	CODE NO.	NAME/DESCRIPTION	CREW	START TIME HR. MIN. SEC.	PLANE (SECS)						
C00001	CONTACT DEPARTURE AFTER TAKEOFF	IP 01	PICK UP MICROPHONE	P 1 2.0	0.0							
		IP 07	MAKE RADIO TRANSMISSION	P 4 4.0	2.0							
		IP 16	HOLD MICROPHONE	P 4 7.0	6.0							
		IT 28	MONITOR RADIO TRANSMISSION	P 2 7.0	6.0							
		IP 10	MAKE RADIO TRANSMISSION	P 4 6.0	13.0							
		IP 04	RETURN MICROPHONE	P 1 2.0	19.0							
C00002	RECEIVE TRAFFIC ADVISORY	IT 28	MONITOR RADIO TRANSMISSION	P 1 6.0	0.0							
		IP 01	PICK UP MICROPHONE	P 1 2.0	6.0							
		IP 07	MAKE RADIO TRANSMISSION	P 3 3.0	8.0							
		8A 01	SCAN OUTSIDE AIRCRAFT	P 1 1.5	8.0							
		IP 04	RETURN MICROPHONE	P 1 2.0	11.0							
C00003	RECEIVE VECTOR	IT 25	MONITOR RADIO TRANSMISSION	P 1 4.0	0.0							
		IP 01	PICK UP MICROPHONE	P 1 2.0	4.0							
		IP 07	MAKE RADIO TRANSMISSION	P 4 4.0	6.0							
		IP 04	RETURN MICROPHONE	P 1 2.0	10.0							
C00004	REPORT CROSSING FIX	IP 01	PICK UP MICROPHONE	P 1 2.0	0.0							
		IP 10	MAKE RADIO TRANSMISSION	P 2 5.0	2.0							
		IP 16	HOLD MICROPHONE	P 2 2.0	7.0							
		IT 22	MONITOR RADIO TRANSMISSION	P 1 2.0	7.0							
		IP 04	RETURN MICROPHONE	P 1 2.0	9.0							
C00005	RECEIVE REQUEST TO SAY ALTITUDE	IT 22	MONITOR RADIO TRANSMISSION	P 1 2.0	0.0							
		IP 01	PICK UP MICROPHONE	P 1 2.0	2.0							
		IP 16	HOLD MICROPHONE	P 1 1.0	4.0							
		3H 01	SCAN ALTIMETER	P 1 1.0	4.0							
		IP 07	MAKE RADIO TRANSMISSION	P 2 2.5	5.0							
		IP 04	RETURN MICROPHONE	P 1 2.0	7.5							

Figure 3.- Workload analysis worksheet.

BOEING
TIA-1
SUBSYSTEM CODING FORM

Page 1 of 1
Date

SUBSYSTEM NAME		ATA CODE NO.
1A	COM #1	
1B	COM #2	
1N	TRANSPONDER	
1P	VOICE	
1T	AUDIO	
3A	AIR SPEED INDICATOR	
3H	ALTIMETER	
3L	VERTICAL SPEED INDICATOR	
3M	CLOCK	
3P	NEEDLE/BALL	
3R	ATTITUDE	
3U	QAT INDICATOR	
3V	MARKER BEACON	
4A	PRIMARY ATTITUDE CONTROL	
4B	PROPULSION CONTROL	
4D	LANDING GEAR	
4E	FLAPS	
4G	TRIM	
5D	ADF/RMI	
5K	MAGNETIC COMPASS	
5P	DME	
5U	NAV #1	
5V	NAV #2	
7B	ELECTRICAL	
7C	FUEL	
7F	ENGINE	
7G	LIGHTS	
7M	ENGINE STARTING	
7V	VACUUM	
8A	VISION	
8B	CHARTS/CHECKLISTS	

Figure 4.- Subsystem coding form.

BOEING
TLA-1
TASK DATA CODING FORM

TASK CODE NO.		TASK NAME AND/OR DESCRIPTION		DURATION TIME (HOURS)		CHANNEL ACTIVITY - PERCENT OF DURATION TIME							VBL	
1A	1B	1	2	EV	IV	LH	SH	LF	RF	COG	AUD	VBL		
01		MOVE AUD. P.M.L. MIKE SWITCH	1	2.5		40	100			10				
04		ADJ. COM #1 VBL.	1	2.6		20	100			10				
07		MOVE COM #1 ON/OFF SWITCH	1	2.5		20	100			10				
10		TUNE COM #1	1	5.0		30	100			10		1A0131		
			2	3.0		20	100			10		1A0132		
			3	2.5		20	100			10		1A0133		
13		SCAN COM #1 FREQ.	1	5.0		70				10		1A0101		
			2	3.0		80				10		1A0102		
			3	2.5		80				10		1A0103		
			4	1.4		100				10				
01		SCAN COM #2 FREQ.	1	5.0		70				10		1B0101		
			2	3.0		80				10		1B0102		
			3	1.4		100				10		1B0103		
04		ADJ. COM #2 VBL.	1	2.6		20	100			10				
07		MOVE COM #2 ON/OFF SWITCH	1	2.5		20	100			10				
10		TUNE COM #2	1	5.0		30	100			10		1B0101		
			2	3.0		20	100			10		1B0102		

Figure 5.- Task data coding form.

BOEING
TLA-1

EVENT/PROCEDURE DATA CODING FORM

EVENT/PROC CODE NO.	EVENT/PROCEDURE NAME OR DESCRIPTION	TASK CODE NO.			TIME START TIME			SLIP (SEC)			TASK CODE NO.			TIME START TIME			SLIP (SEC)		
		HR	MIN	SEC	HR	MIN	SEC	HR	MIN	SEC	HR	MIN	SEC	HR	MIN	SEC	HR	MIN	SEC
C00011	CONTACT TOWER	1P	01	0.0	1P	07	0.0	1P	07	0.0	1P	07	0.0	1P	07	0.0	1P	07	0.0
		1P	19	5.0															
		1P	07	12.5															
C00001	CHANGE TRANSCIVERS	1A	01	0.0	1A	01	0.0	1A	01	0.0	1A	01	0.0	1A	01	0.0	1A	01	0.0
		1T	01	5.3															
C00002	TUNE COM. #1	1A	13	0.0															
C00003	TUNE COM. #2	1B	01	0.0															
C00004	CHANGE TRAN. CODE	1N	16	0.0															
F00001	TAKEOFF ROLL	4B	07	0.0	4B	07	0.0	4B	07	0.0	4B	07	0.0	4B	07	0.0	4B	07	0.0
		7F	04	0.0															
		7F	01	5.2															
F00002	ROTATE AND LIFT OFF	4A	04	0.0	4A	04	0.0	4A	04	0.0	4A	04	0.0	4A	04	0.0	4A	04	0.0
		4A	07	4.0															
		3A	01	5.0															
		4A	10	8.0															
		3R	01	9.2															
		1N	04	12.9															
F00003	REDUCE SPEED	4B	07	0.0	4B	07	0.0	4B	07	0.0	4B	07	0.0	4B	07	0.0	4B	07	0.0
		3R	01	2.6															
		3A	01	5.6															
		3L	01	7.6															
		3R	01	11.8															
		3A	01	12.8															
		3L	01	14.8															
		3R	01	17.0															
		3A	01	20.0															
		4A	07	21.6															
		4A	10	22.6															
		3R	01	26.2															

Figure 6.-- Event/procedure data coding form.

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TLA-1
MISSION DATA CODING FORM

MISSION	NAME	OF
PROJECT	DATE	

MISSION PARAMETERS				TIME				STR TM				SLIDE				SLIDE				CONFIGURATION							
RUN DATE				INITIAL (SEC)				HR MIN				THSND				CODE				TITLE							
APRIL 1976				20				0000				999				1 GA - SPIR											
ATL TLR SCENARIO																											
JLS RWY 8																											
MISSION PROFILE																											
NO. 10																											
PHASE START TIME				PHASE START TIME				PHASE START TIME				PHASE START TIME				PHASE START TIME				PHASE START TIME							
CODE NO.				CODE NO.				CODE NO.				CODE NO.				CODE NO.				CODE NO.							
T001 0000				CLO2 036				CR03 432				H004 1025				IA05 2006				INIT 6 3051				F0M7 3344			
FM18 3633				FRY9 3925				TD10 3947																			
CREWMEMBERS																											
NO. 1																											
NAME				NAME				NAME				NAME				NAME				NAME				NAME			
P PILOT																											

Figure 8.- Mission data coding form.

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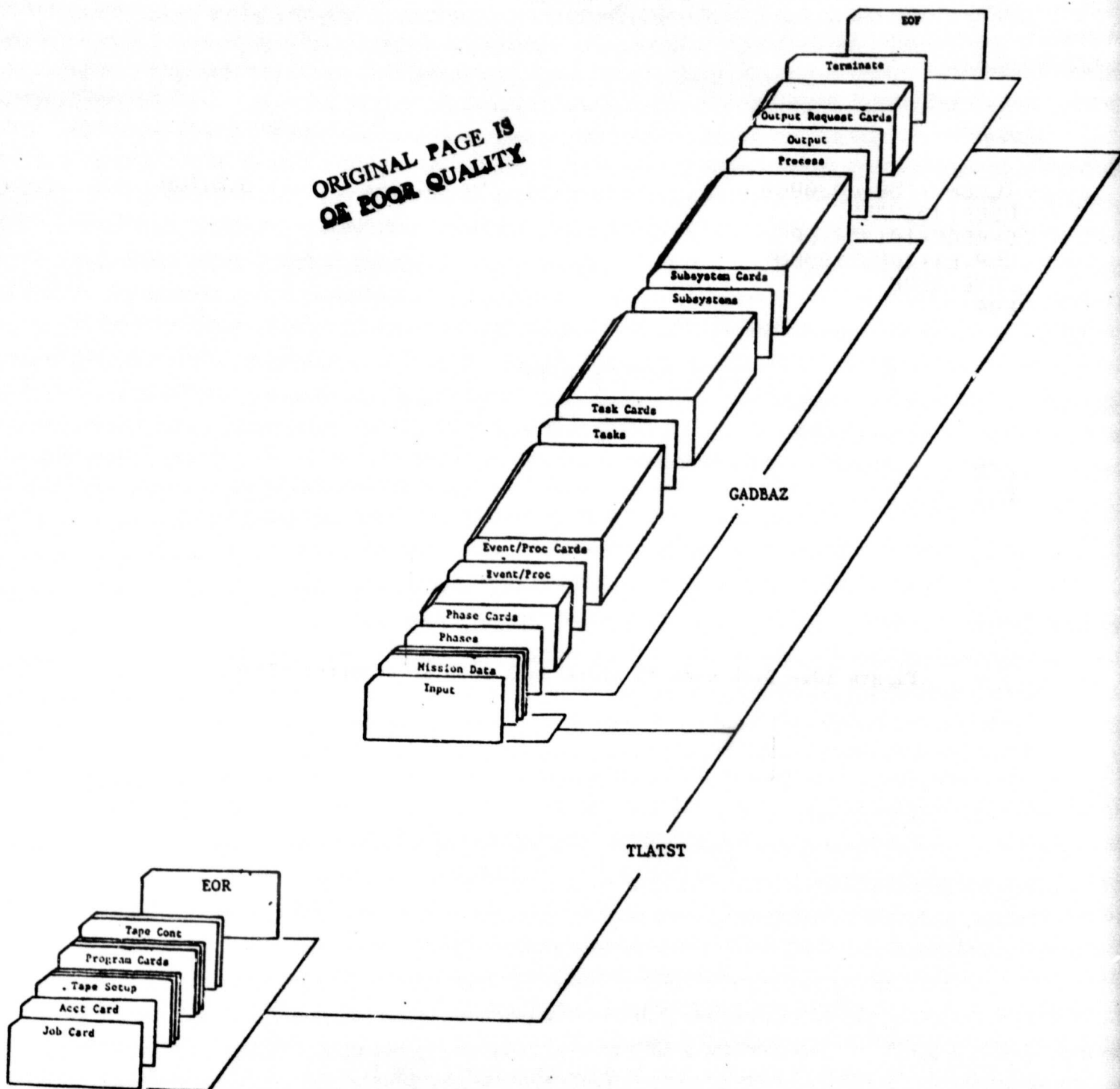


Figure 9.- Data base and control card deck arrangement.

TLACPY, T50, CM20000.
USER, 403225N.
CHARGE, 101354, LRC.
COPYEI, INPUT, DUMMY.
SAVE, DUMMY.
EOR

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OF POSITIVE
RM1142

HINTON

DATA PLACED HERE

EOR
EOI

Figure 10.- Deck used to store data base in computer files.

/JOB
GNRLAV,T350,CM240000.

RM 1142 D HINTON

26

USER,403225N.
CHARGE,101354,LRC.
GET,GADBAZ.
REWIND,GADBAZ.
COPYBR,INPUT,DATA.
COPYBR,GADBAZ,DATA.
COPYBR,INPUT,DATA.
REWIND,DATA.
PACK,DATA.
GET,TLABN3.
ATTACH,LRCGOSF/UN=LIBRARY.
LDSET,LIB=LRCGOSF,PRESETA=NGINF,MAP=N.
TLABN3,DATA,PL=50000.
ATTACH,PLOT/UN=LIBRARY,NA.
REWIND,TAPE99.
PLOT,VARIAN(PVF=TAPE99,AUTO)
EXIT.
DMD.

/EOR
/NOSEQ
INPUT

APRIL 1978 ATL TLA SCENARIO 20 0000 1 999 1 GA - SPIFR
ILS RWY 8

10
T001 0 0 0 CL02 036 CR03 432 H004 1025 IA05 2006 INT6 3051 FOM7 3344
FMM8 3633 FRY9 3925 TD10 3947

1
P PILOT

/SEQ
/EOR

PROCESS
OUTPUT

CWP	P	U	****		
MSN	P	U	****		
WLH	P	U	****	100	IV 1
WLH	P	U	****	100	EV 1
WLH	P	U	****	100	LH 1
WLH	P	U	****	100	RH 1
WLH	P	U	****	100	LF 1
WLH	P	U	****	100	AUD 1
WLH	P	U	****	100	VBL 1
WLH	P	U	****	100	COG 1

TERMINATE
/EOR

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OF POOR QUALITY

Figure 11.- TLATST.

 * UNSHIFTED *

 * CREWMAN WORKLOAD PROFILE REPORT *
 * MISSION - ATL TLA SCENARIO *
 * ILS Rwy 8 *
 * CONFIGURATION - GA - SPIR *
 * CREWMEMBER - PILOT *
 * FLIGHT PHASE - CRUISE TO HOLDING *
 * PATTERN *

APRIL 1976

TIME INTERVAL (SECONDS) START	EXTERNAL VISION	INTERNAL VISION	LEFT HAND	RIGHT HAND	LEFT FOOT	RIGHT FOOT	COGNITION	AUDIO	VERBAL	TOTAL VISION	TOTAL MOTOR	TOTAL COMM	AVERAGE
260.	0.00	99.00	19.63	25.00	19.63	19.63	20.90	0.00	0.00	99.00	20.97	0.00	35.22
280.	0.00	93.50	31.62	0.00	16.62	16.62	16.00	0.00	0.00	93.50	16.22	0.00	31.43
300.	0.00	89.50	18.75	0.00	18.75	19.75	16.45	0.00	0.00	89.50	14.06	0.00	30.00
320.	0.00	83.00	30.00	15.00	15.00	15.00	15.30	0.00	5.00	83.00	18.75	5.00	30.51
340.	0.00	71.50	7.50	50.00	7.50	7.50	16.15	10.00	15.00	71.50	18.13	25.00	32.69
360.	0.00	93.00	12.50	0.00	12.50	12.50	14.30	0.00	0.00	93.00	9.38	0.00	29.17
380.	0.00	93.00	12.50	0.00	12.50	12.50	14.30	0.00	0.00	93.00	9.38	0.00	29.17
400.	0.00	92.00	9.63	0.00	9.63	9.63	13.05	0.00	0.00	92.00	7.22	0.00	28.07
420.	0.00	88.00	11.25	0.00	11.25	11.25	13.30	0.00	0.00	88.00	8.44	0.00	27.43
440.	0.00	93.00	12.50	0.00	12.50	12.50	14.30	0.00	0.00	93.00	9.38	0.00	29.17
460.	0.00	88.50	10.38	0.00	10.38	10.38	13.00	0.00	0.00	88.50	7.78	0.00	27.32
480.	0.00	93.00	12.50	0.00	12.50	12.50	14.30	0.00	0.00	93.00	9.38	0.00	29.17
500.	0.00	93.00	12.50	0.00	12.50	12.50	14.30	0.00	0.00	93.00	9.38	0.00	29.17

Figure 12.- Sample of crewman workload profile report.

* UNSHIFTED *

APRIL 1978

* MISSION SCENARIO REPORT *
* MISSION - ATL TLA SCENARIO *
* ILS RWY 8 *
* CONFIGURATION - GA - SPIFR *
* CREWMEMBER - PILOT *

TIME INTERVAL (SECS)
SINCE MISSION START
BEGINNING END

272.00

272.00

272.00

273.00

275.20

277.20

276.30

281.30

277.20

279.30

280.30

281.30

TOTAL
ACTIVITY
TIME

1.00

2.20

2.00

5.00

2.10

1.00

1.00

FLIGHT PHASE
EVENT/PROCEDURE
TASK

CR03 CRUISE TO HOLDING
PATTERN

F00010 MAINTAIN STRAIGHT
AND LEVEL WITH
VOR MON.

3H 01 SCAN ALTITUDE
USE SIT 2 WITH
3H0071 AND 3H0042

3L 01 SCAN VERTICAL SPEED

5D 01 SCAN P RMI

4A 10 MOVE CONTROLS
FOR MANUAL CONTROL

5U 01 SCAN P #1 VOR/LOC GS
USE SIT 263 WITH
5U0131

3A 01 SCAN P AIRSPEED IND.
SIT 2 FOR TAKEOFF

3R 01 SCAN P ATTITUDE IND.

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Figure 13.- Sample of mission scenario report.

UNSHIFTED

APRIL 1978

WORKLOAD HISTOGRAM

CREWMEMBER - PILOT

CHANNEL - EXTERNAL VISION

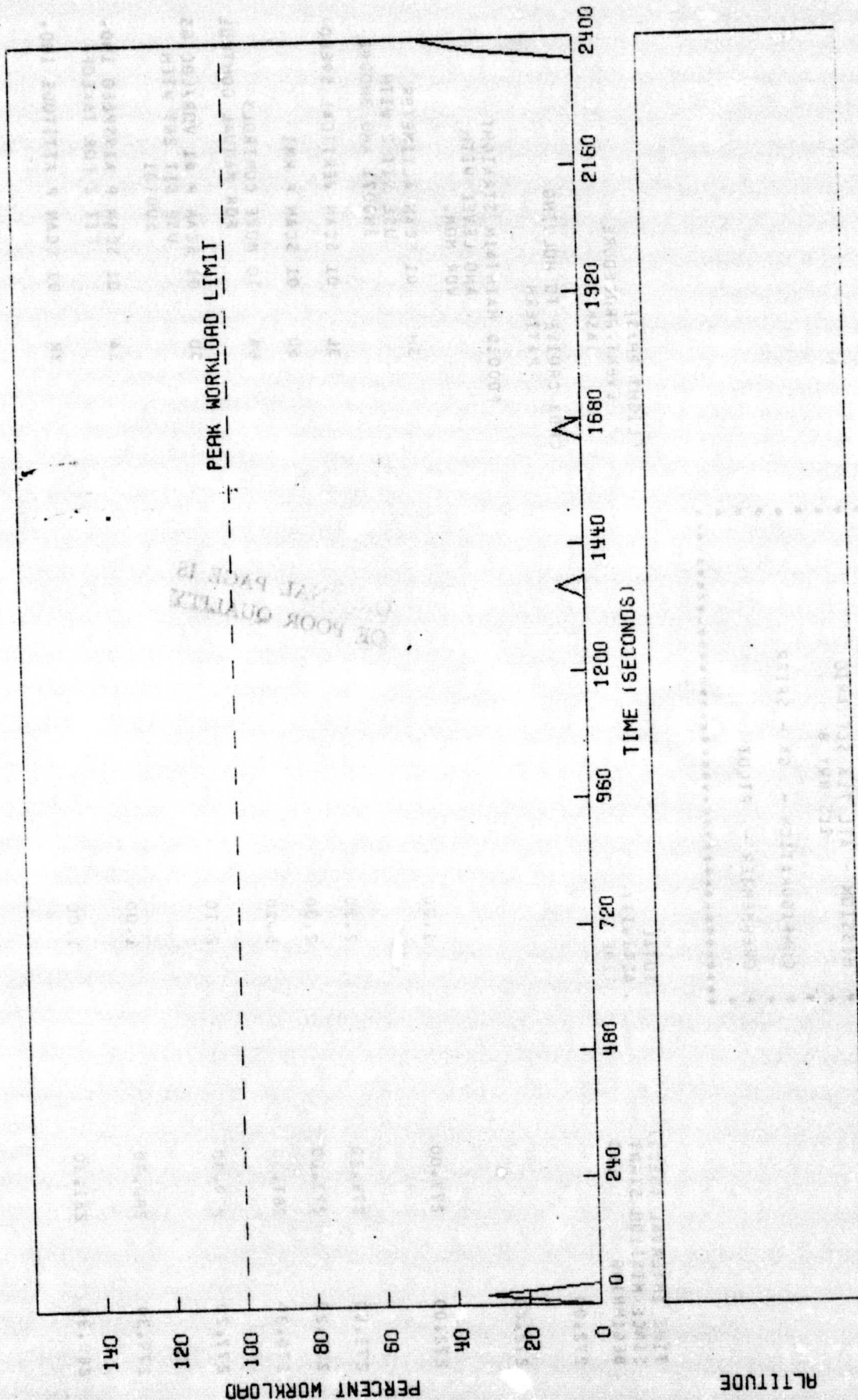
MISSION
ATL TLA SCENARIO
ILS RWY 8CONFIGURATION
GR - SPIR

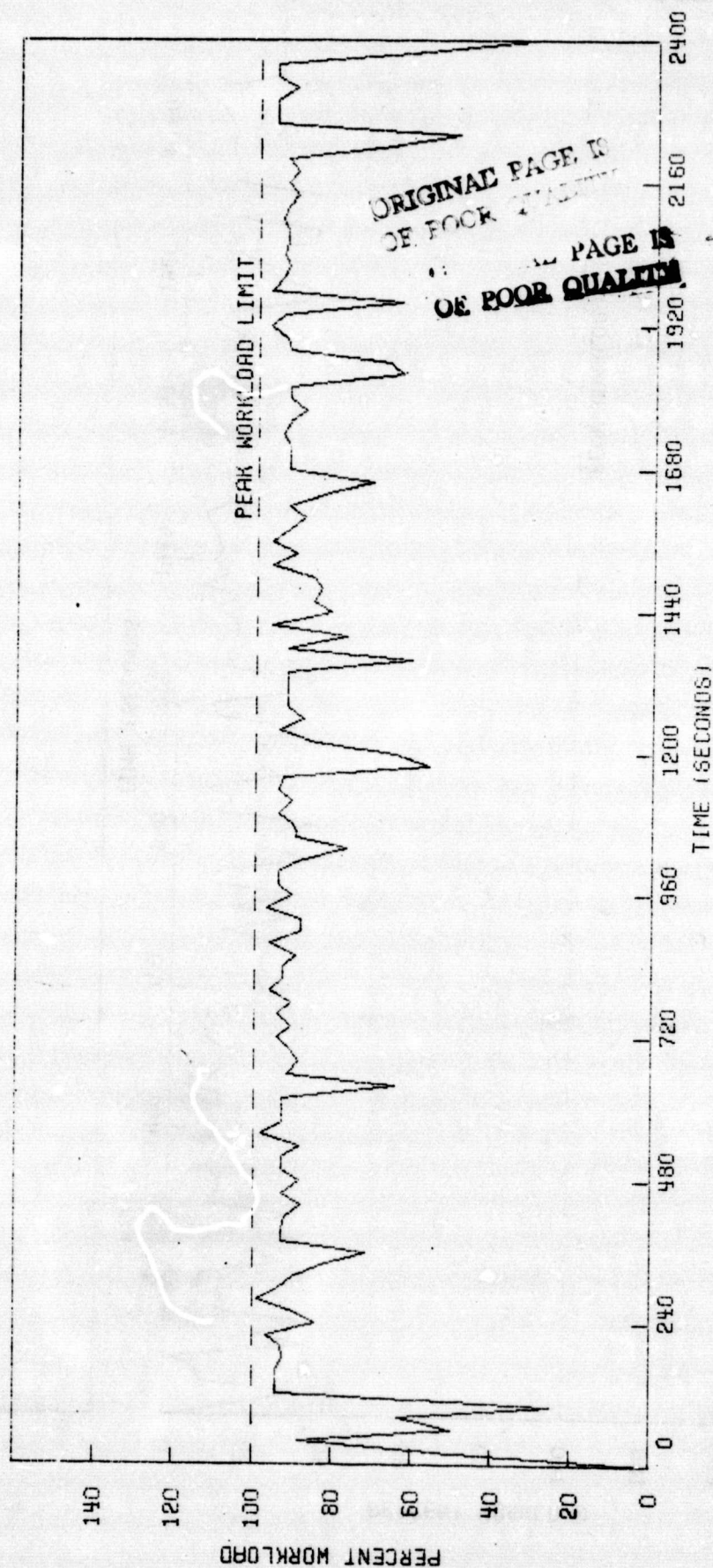
Figure 14.- External vision workload histogram report.

UNSHIFTED
APRIL 1978

WORKLOAD HISTOGRAM
CREWMEMBER - PILOT
CHANNEL - INTERNAL VISION

MISSION
ATL TLR SCENARIO
ILS RWY 8

CONFIGURATION
GA - SPIFR



ALTITUDE

Figure 15.- Internal vision workload histogram report.

UNSHIFTED
APRIL 1978

WORKLOAD HISTOGRAM
CREWMEMBER - PILOT
CHANNEL - LEFT HAND

MISSION
ATL TLA SCENARIO
ILS RWY 6

CONFIGURATION
GA - SPIFR

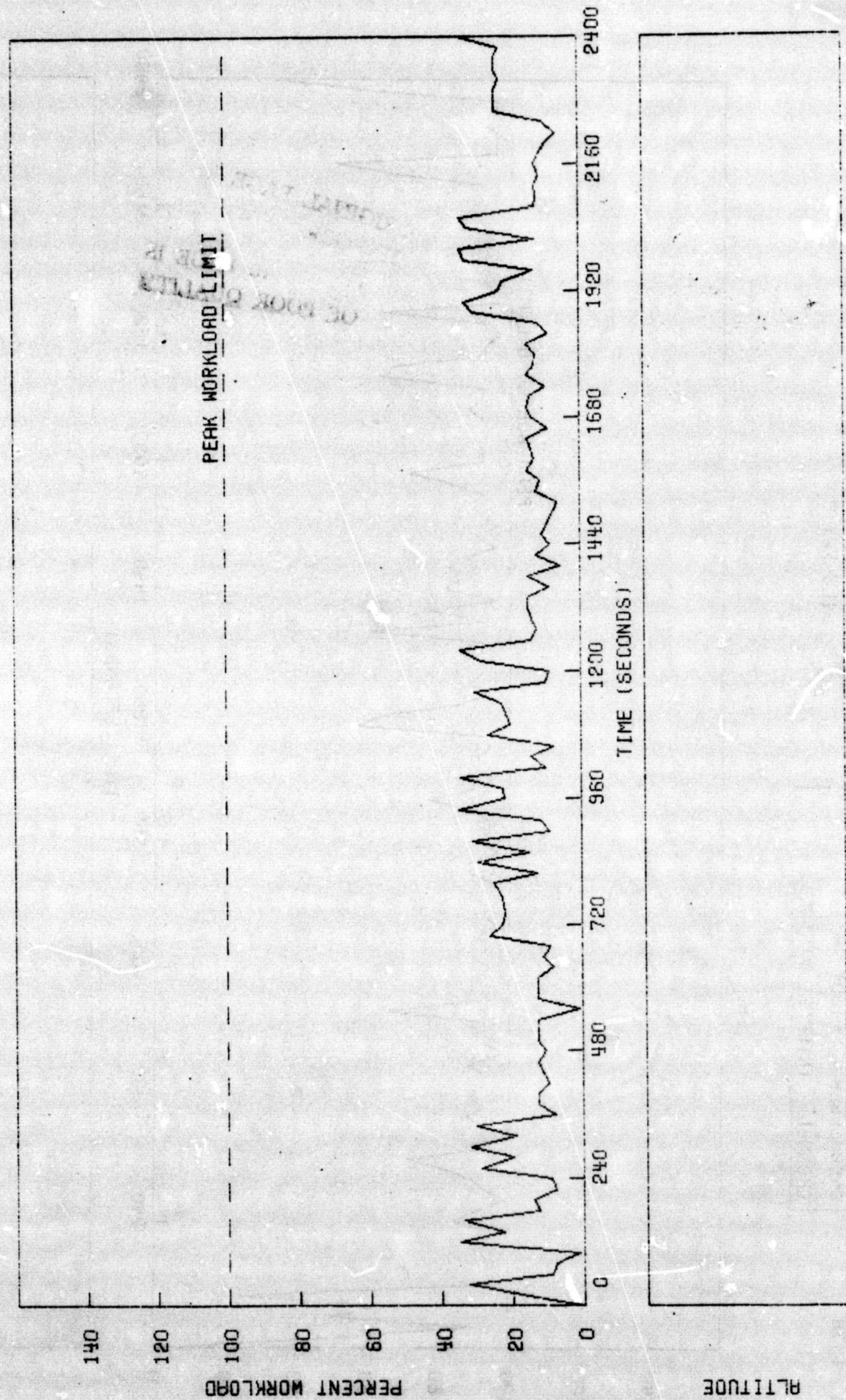


Figure 16.- Left hand workload histogram report.

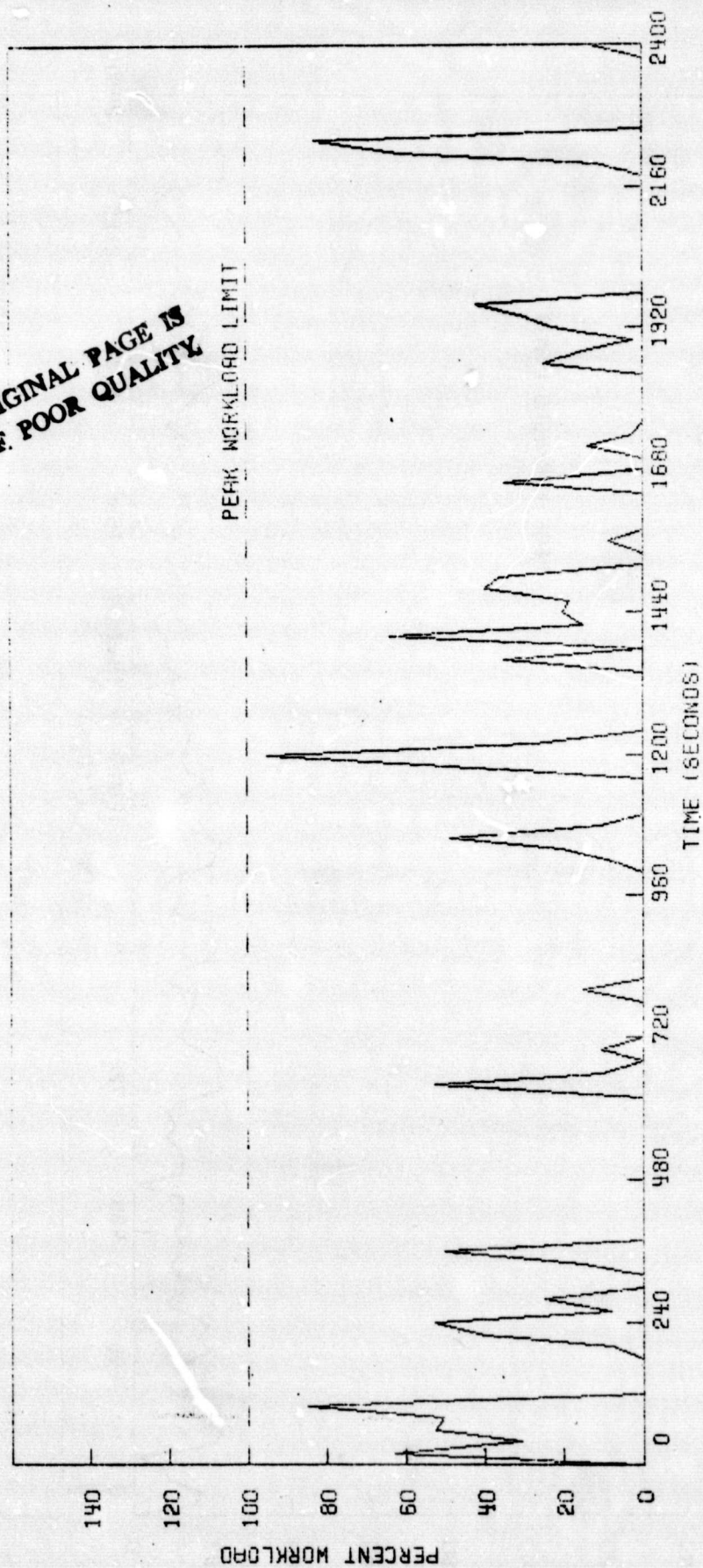
UNSHIFTED
APRIL 1978

WORKLOAD HISTOGRAM
CREWMEMBER - PILOT
CHANNEL - RIGHT HAND

MISSION
ATL TLR SCENARIO
ILS RAY 8

CONFIGURATION
GA - SPIR

ORIGINAL PAGE IS
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PLITUDE

Figure 17.- Right hand workload histogram report.

UNSHIFTED

APRIL 1978

WORKLOAD HISTOGRAM

CREWMEMBER - PILOT

CHANNEL - LEFT FOOT

MISSION
ATL TLA SCENARIO
ILS RWY 8

CONFIGURATION
GA - SPIFR

28

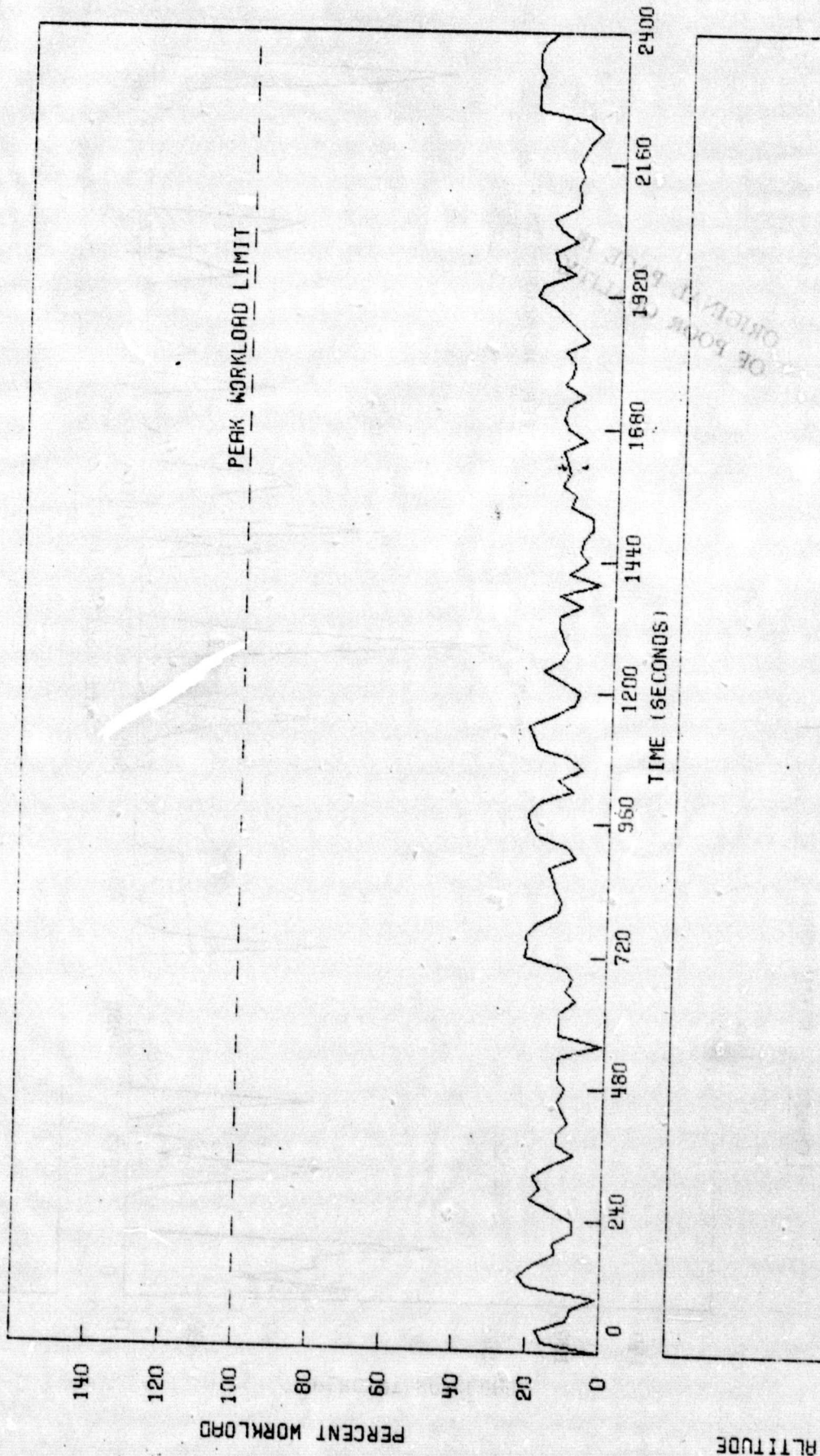


Figure 18.- Left foot workload histogram report.

UNSHIFTED
APRIL 1978

WORKLOAD HISTOGRAM
CREWMEMBER - PILOT
CHANNEL - AUDITORY

MISSION
ATL TLA SCENARIO
ILS RAY 6

CONFIGURATION
GA - SPIR

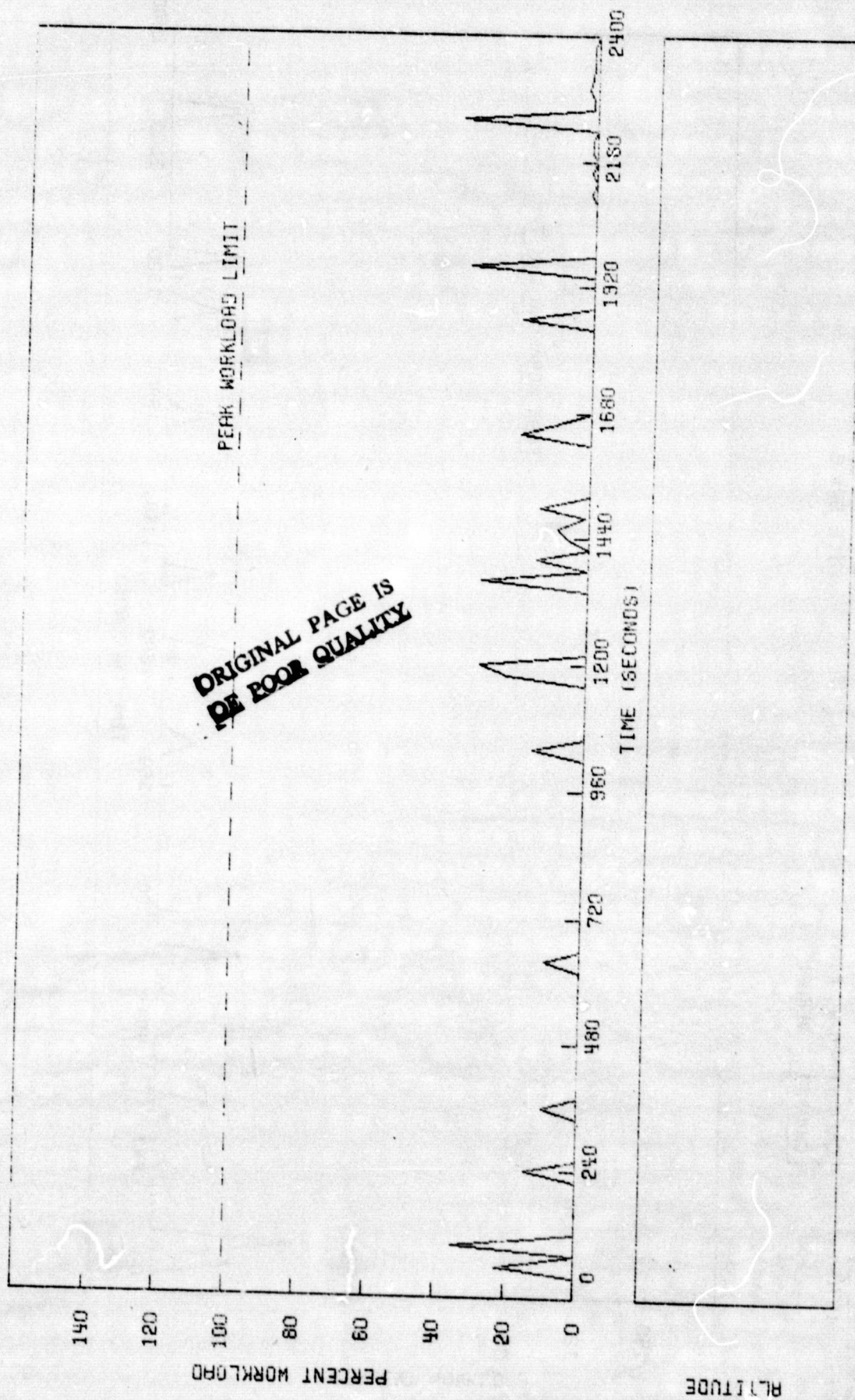


Figure 19.- Auditory workload histogram report.

UNSHIFTED

APRIL 1978

WORKLOAD HISTOGRAM

CREWMEMBER - PILOT

CHANNEL - VERBAL

MISSION
ATL TLA SCENARIO
ILS RWY 6

CONFIGURATION
GA - SPIR

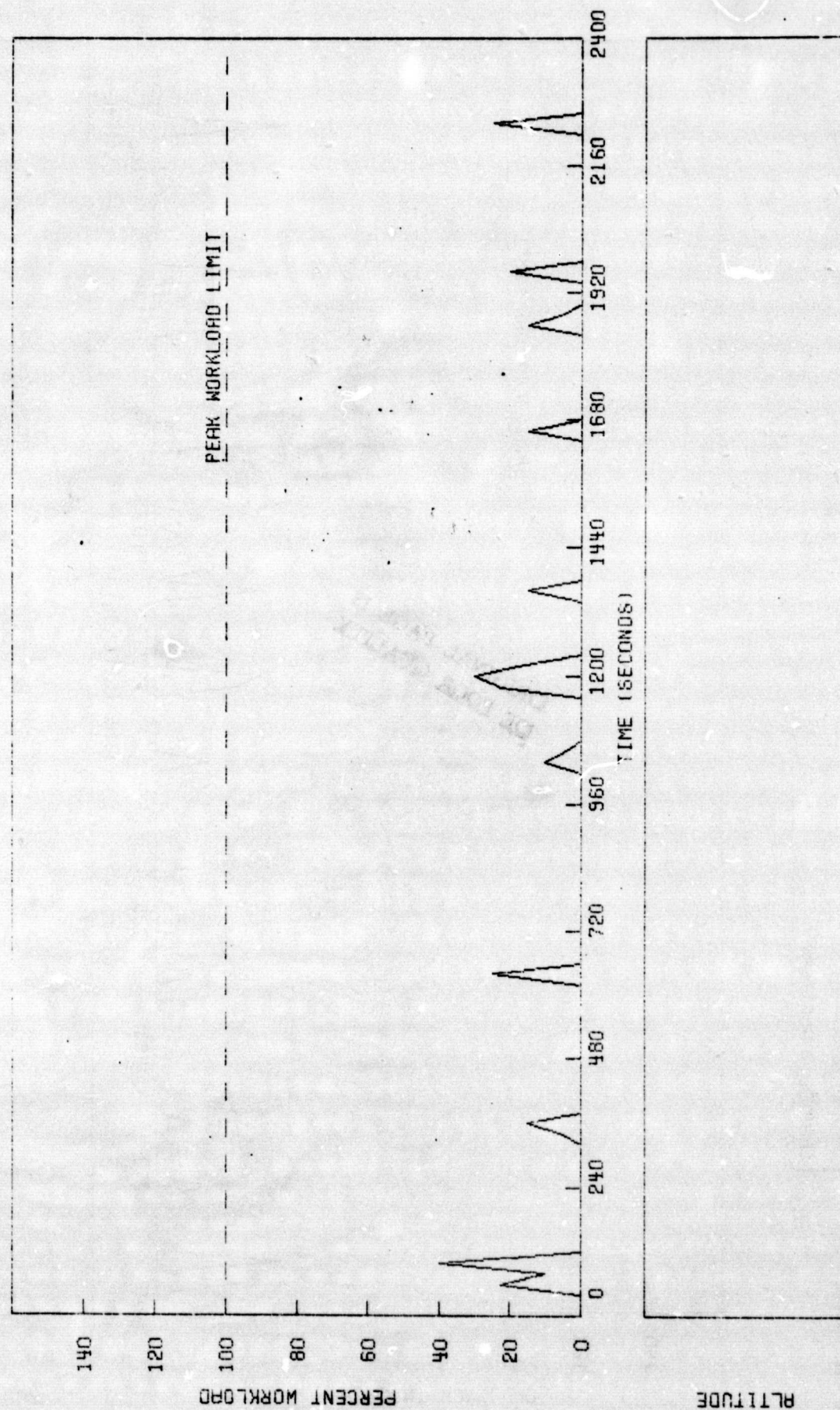


Figure 20.- Verbal workload histogram report.

UNSHIFTED
APRIL 1978

MISSION
41L TLR SCENARIO
ILS RWY 6

WORKLOAD HISTOGRAM
CREW/ENGINEER - PILOT
CHANNEL - COGNITIVE

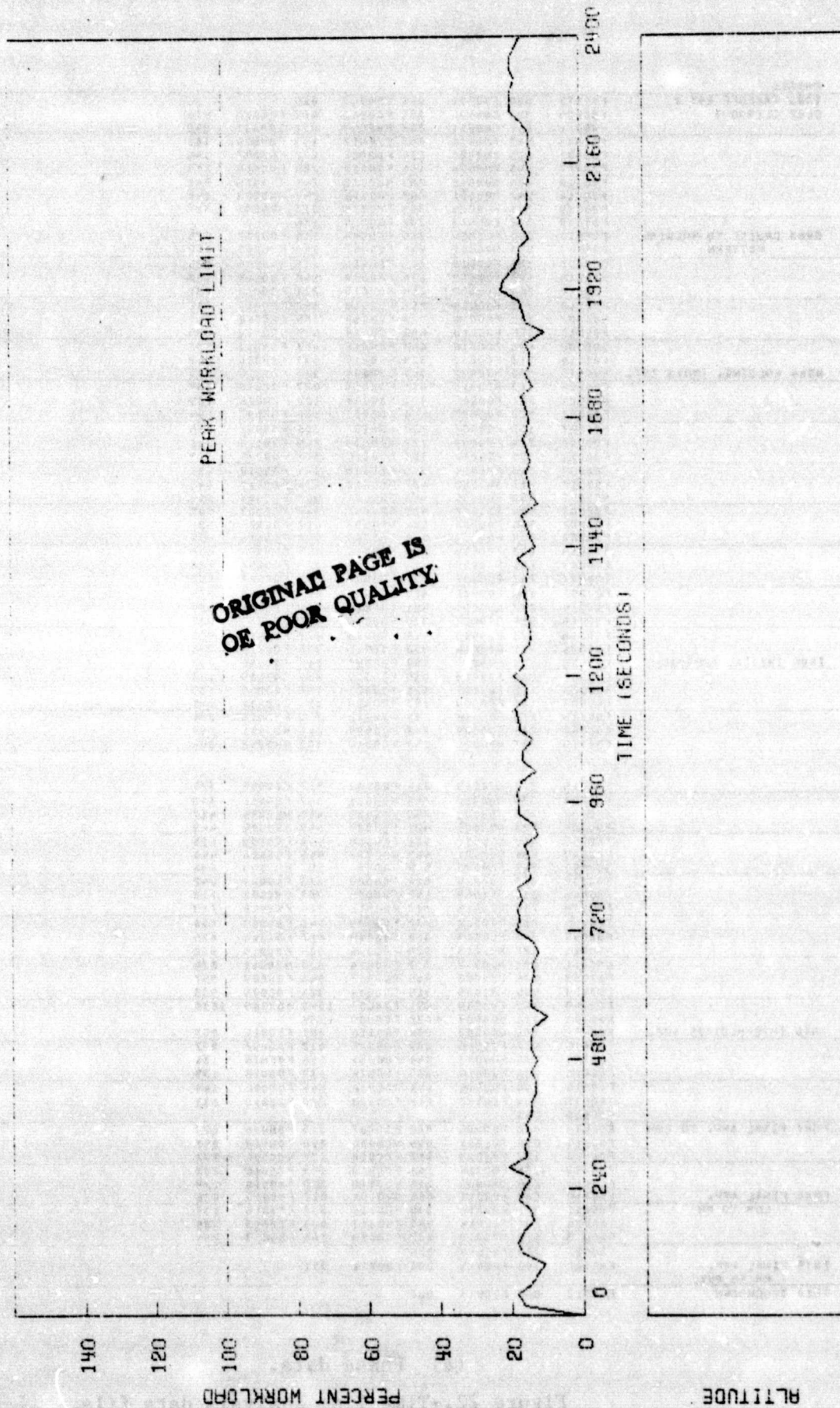


Figure 21.- Cognitive workload histogram report.

PHASES						
T001 TAKEOFF RMY 8 CL02 CLIMBOUT	EVENT1	000 F00001	000 F00002	020		
	F00009	000 C00006	009 F00016	012 F00016	016	
	F00016	017 CR0001	022 F00009	031 C00001	040	
	F00016	043 F00016	053 EVENT2	101 F00006	101	
	F00007	116 F00007	124 F00007	132 F00007	140	
CR03 CRUISE TO HOLDING PATTERN	F00007	148 F00008	156 F00010	209 F00010	219	
	F00010	229 N00010	239 N00012	241 F00016	241	
	F00010	242 NR0001	252 F00016	257 NR0003	258	
	F00010	301 NR0004	311 F00016	316 NR0005	317	
	F00010	326 EVENT3	336 F00005	336		
M004 HOLDING, TROYS INT.	F00010	000 EVENT4	010 F00006	010 F00007	025	
	F00007	033 N00001	041 F00007	044 F00008	052	
	C00007	105 F00016	111 F00010	115 NR0006	125	
	F00010	128 F00010	138 F00010	148 F00010	158	
	F00010	208 N00002	218 F00010	221 F00010	231	
I005 INITIAL APPROACH	F00010	242 F00010	252 F00010	302 F00010	312	
	N00002	322 F00010	325 F00010	335 F00010	345	
	F00010	355 F00010	405 F00010	415 N00002	425	
	S00002	428 F00010	443 F00010	453 F00010	503	
	F00010	513 F00010	523 F00010	533 F00010	543	
F00007	000 N00007	000 C00004	006 F00016	009		
	F00016	013 F00010	017 F00010	027 F00010	037	
	N00004	047 F00010	050 N00008	100 F00006	105	
	F00007	120 F00007	128 F00007	136 F00007	144	
	F00007	152 F00007	200 F00007	208 F00007	216	
INT6 INTERMEDIATE APP.	F00007	224 F00008	232 NR0003	245 F00010	248	
	F00010	258 F00010	308 F00010	318 F00006	328	
	F00007	343 N00001	351 F00008	354 F00010	407	
	F00010	417 N00002	427 F00010	430 F00010	440	
	N00002	450 F00006	453 F00007	508 F00007	516	
F00009	524 F00007	532 F00007	540 F00007	548		
	F00007	556 F00008	604 N00009	617 F00009	621	
	F00009	630 F00003	639 C00008	648 F00016	650	
	F00016	653 F00016	654 F00016	655 CR0004	658	
	F00009	705 F00009	714 N00008	723 F00006	728	
F00007	743 F00007	751 F00007	759 F00007	807		
	F00007	815 F00007	823 F00007	831 F00008	839	
	F00010	852 C00006	901 F00016	904 F00016	909	
	F00016	914 CR0002	915 F00016	920 C00007	921	
	F00016	923 F00016	925 F00016	927 F00016	929	
F00009	931 F00016	933 F00016	930 F00016	938		
	EVENT6	000 F00006	000 F00007	715 F00008	023	
	F00009	036 F00009	045 F00009	154 F00009	103	
	F00009	112 F00009	121 F00009	130 F00009	139	
	F00009	148 F00009	157 F00009	206 C00002	215	
F00016	216 F00016	218 F00016	220 F00016	224		
	F00009	228 F00009	237 F00009	246 N00011	255	
	F00016	257 NR0001	258 F00016	303 NR0002	304	
	F00016	313 NR0003	314 F00009	317 F00009	326	
	F00009	335 N00003	344 N00011	347 F00016	349	
F00009	NR0008	350 F00009	359 F00009	408 NR0004	417	
	F00009	422 NR0005	431 F00009	440 NR0006	449	
	F00009	452 S00002	501 F00009	516 F00009	525	
	F00009	534 S00001	543 N00012	545 F00016	545	
	S00001	546 F00009	548 F00009	557 F00009	606	
F00009	615 F00009	624 F00009	633 F00009	642		
	F00016	651 F00009	652 F00009	701 C00002	710	
	F00016	711 F00016	713 F00016	715 F00016	719	
	F00009	723 F00009	732 F00009	741 F00009	750	
	F00009	759 F00009	808 F00009	817 F00016	826	
F00009	N00011	827 N00013	829 F00016	829 F00016	830	
	N00011	831 N00012	833 F00016	833 N00011	834	
	F00009	836 N00003	845 F00009	848 F00009	857	
	F00009	906 F00009	915 F00009	924 F00009	933	
	F00009	942 F00009	951 F00009	1000 F00009	1009	
F00009	N00003	1018 F00009	1027 F00009	1036		
	EVENT7	000 C00003	000 F00016	001 F00016	003	
	F00016	007 F00016	009 F00006	012 F00007	027	
	F00008	035 F00003	048 F00004	116 EVENT8	114	
	C00013	134 F00016	135 F00016	137 F00016	139	
F00016	144 F00016	145 F00016	146 F00006	149		
	F00007	204 F00007	212 F00008	220 F00010	233	
	F00010	243				
	EVENT9	000 F00006	000 F00007	015 F00008	023	
	F00010	036 F00010	046 N00006	056 F00010	057	
F00010	107 F00010	117 F00010	127 N00006	137		
	F00010	138 F00010	148 F00010	153 F00010	208	
	F00010	218 N00006	228 F00010	229 F00010	239	
	EVENT10	000 F00012	000 CR0001	017 F00016	026	
	C00011	027 F00016	030 F00016	032 F00016	035	
F00016	037 F00016	048 F00013	044 F00013	100		
	F00013	116 F00013	132 F00013	148 F00013	204	
	F00013	220 F00013	236			
	EVENT11	000 F00014	000 F00014	011		
	FRY9 FINAL APP. NM TO RMY					
TD10 TOUCHDOWN	EVENT12	000 F00015	000			

(a) Phase data.

Figure 22.-Time line analysis data file.

EVENT/PROC							
C00001 CONTACT DEP. AFTER	1P	01	0.0	P1 1P	07	2.0	P4
TAKEOFF	1P	16	6.0	P4 1T	20	6.0	P2
	1P	10	13.0	P4 1P	04	19.0	P1
C00002 RECEIVE TRAFFIC	1T	28	0.0	P1 1P	01	6.0	P1
ADVISORY	1P	07	8.0	P3 8A	01	8.0	P1
	1P	04	11.0	P1			
C00003 RECEIVE VECTOR	1T	25	0.0	P1 1P	01	4.0	P1
	1P	07	6.0	P4 1P	04	10.0	P1
C00004 REPORT CROSSING FIX	1P	01	0.0	P1 1P	10	2.0	P2
	1P	16	7.0	P2 1T	22	7.0	P1
	1P	04	9.0	P1			
C00005 RECEIVE REQUEST TO	1T	22	0.0	P1 1P	01	2.0	P1
SAY ALTITUDE	1P	16	4.0	P1 3H	01	4.0	P1
	1P	07	5.0	P2 1P	04	7.3	P1
C00006 RECEIVE HANDOFF	1T	25	0.0	P2 1P	01	4.3	P1
	1P	10	6.5	P1 1P	04	11.0	P1
C00007 REPORT REACHING ALT.	1P	01	0.0	P1 1P	07	2.0	P4
	1P	16	6.0	P2 1T	22	6.0	P1
	1P	04	8.0	P1			
C00008 RECEIVE TRAN. CODE	1T	22	0.0	P3 1P	01	3.0	P1
CHANGE	1P	07	5.0	P3 1P	04	8.0	P1
C00009 CONTACT APPROACH	1P	01	0.0	P1 1P	07	2.0	P4
	1P	16	6.0	P3 1T	28	6.0	P1
	1P	10	12.0	P3 1P	04	17.5	P1
C00010 RECEIVE FINAL VECTOR	1T	22	0.0	P2 1P	01	7.0	P1
AND HANDOFF TO THR	1P	07	9.0	P4 1P	04	13.0	P1
C00011 CONTACT TOWER	1P	01	0.0	P1 1P	07	2.0	P3
	1P	19	5.0	P1 1T	28	5.0	P3
	1P	07	12.5	P1 1P	04	14.5	P1
C00001 CHANGE TRANSCEIVERS	1A	01	0.0	P1 1T	04	2.5	P1
	1T	01	5.3	P1			
C00002 TUNE COM. #1	1A	13	0.0	P1 1A	10	0.0	P1
C00003 TUNE COM. #2	1B	01	0.0	P1 1B	10	0.0	P1
C00004 CHANGE TRAN. CODE	1N	16	0.0	P2 1N	19	0.0	P2
F00001 TAKEOFF ROLL	4B	07	0.0	P1 4A	16	0.0	P1
	7F	04	2.6	P1 7F	10	5.2	P1
	7F	01	7.4	P1 3A	01	10.0	P2
	4A	16	10.0	P2			
F00002 ROTATE AND LIFTOFF	4A	04	0.0	P1 3R	01	0.0	P3
	4A	07	4.0	P4 3R	01	4.0	P1
	3A	01	5.0	P1 3L	01	6.0	P1
	4A	10	8.0	P1 3H	01	8.2	P1
	3R	01	9.2	P3 4G	13	9.2	P1
	1N	04	12.9	P1			
F00003 REDUCE SPEED	4B	07	0.0	P2 7F	01	0.0	P2
	3R	01	2.6	P2 4A	10	2.6	P2
	3A	01	5.6	P1 3H	01	6.5	P1
	3L	01	7.6	P1 5D	01	9.8	P1
	3R	01	11.8	P1 4A	10	12.5	P1
	3A	01	12.8	P1 3H	01	13.8	P1
	3L	01	14.8	P1 4G	13	17.0	P1
	3R	01	17.0	P2 4A	07	17.6	P4
	3A	01	20.0	P1 3H	01	21.0	P1
	4A	07	21.6	P1 3L	01	22.0	P1
	4A	10	22.6	P1 5D	01	24.2	P1
	3R	01	26.2	P1			
F00004 CHANGE FLAP SETTING	4E	04	0.0	P1 4E	01	0.0	P2
	3R	01	2.4	P2 4A	07	2.4	P2
	3A	01	5.4	P1 4A	07	5.4	P2
	3H	01	6.4	P1 3L	01	7.4	P1
	4A	10	7.4	P2 3R	01	9.6	P2
	4G	13	9.6	P1 3A	01	12.6	P1
	3H	01	13.6	P1 3L	01	14.6	P1
	3R	01	16.8	P1			
F00005 LEVEL OFF AT ALT.	3R	01	0.0	P1 3H	01	1.0	P1
	4A	04	2.0	P1 3R	01	2.0	P3
	3H	01	6.0	P1 4A	10	6.0	P2
	3L	01	7.0	P1 3A	01	9.2	P1
	5D	01	10.2	P1 3R	01	12.2	P1
	4B	07	13.2	P2 7F	01	13.2	P2
	4G	13	15.8	P1 3R	01	15.8	P3
	4A	07	16.0	P4			
F00006 ENTER TURN	3R	01	0.0	P1 5D	01	1.0	P1
	4A	01	3.0	P1 3R	01	3.0	P3
	3H	01	7.0	P1 3L	01	8.0	P1
	4A	10	9.4	P1 3P	01	10.2	P1
	5D	01	11.4	P1 3R	01	13.4	P1
F00007 MAINTAIN TURN	4A	10	0.0	P1 5D	01	0.0	P1
	3H	01	2.0	P1 3L	01	3.0	P1
	3P	01	5.2	P1 4A	07	5.4	P2
	3R	01	6.4	P1			
F00008 EXIT TURN	5D	01	0.0	P1 3R	01	2.0	P3
	4A	01	2.0	P1 5D	01	6.0	P1
	4A	10	7.2	P1 3H	01	8.0	P1
	3L	01	9.0	P1 3R	01	11.2	P1

ORIGINAL PAGE IS
OF POOR QUALITY

(b) Event/procedure data.
Figure 22.- continued

F00009 MAINTAIN STRAIGHT AND LEVEL WITHOUT VOR MON.	3L 01 0.0 3R 01 3.2 5D 01 4.2 3R 01 7.2	P1 3H 01 2.2 P1 4A 10 3.2 P1 3A 01 6.2 P1
F00010 MAINTAIN STRAIGHT AND LEVEL WITH VOR MON.	3L 01 0.0 5D 01 3.2 5U 01 5.2 3R 01 8.3	P1 3L 01 1.0 P1 4A 10 4.3 P1 3A 01 7.3 P1
F00011 BEGIN CLIMB/DESCENT	3R 01 0.0 4B 07 2.0 4A 04 4.6 3H 01 8.6 3L 01 9.6 5D 01 12.8	P1 3H 01 1.0 P1 7F 01 2.0 P1 3R 01 4.6 P1 4A 10 8.6 P1 3A 01 11.8 P1 3R 01 14.8
F00012 CROSS OUTER MARKER	4G 13 14.8 3V 07 0.0 3N 01 2.6 7F 01 4.8 3L 01 8.4 4A 07 12.7	P1 5U 01 0.5 P1 4B 07 4.8 P2 3R 01 7.4 P1 5U 01 10.6 P4 3R 01 12.7
F00013 FLY ILS, OM TO MM	4G 13 12.7 4A 10 0.0 3L 01 1.0	P1 P3 3R 01 0.0 P1 5U 01 3.2
	3H 01 5.3 5D 01 7.3 5U 01 10.5 3A 01 13.6	P1 3R 01 6.1 P1 3P 01 9.3 P1 3R 01 12.6 P1 3V 04 14.6
F00014 FLY ILS, MM TO RWY	4A 10 0.0 8A 01 1.0 3A 01 6.1 3H 01 9.3	P2 3R 01 0.0 P4 5U 01 4.0 P1 3L 01 7.1 P1
F00015 FLARE AND TOUCHDOWN	4A 04 0.0 8A 04 0.0 8A 04 4.0 3R 01 0.0	P1 4B 07 0.0 P2 4A 10 4.0 P4 P1 4A 07 0.0
F00016 MAINTAIN ATTITUDE	3R 01 0.0 5U 01 0.0	P1 P1
N00001 CHECK #1 VOR NEEDLE	5V 01 0.0	P1
N00002 CHECK #2 VOR NEEDLE	5D 14 0.0	P1 5D 15 0.5
N00003 CHECK ADF ARROW	3N 01 0.0	P1
N00004 CHECK STOPWATCH IND.	5U 01 0.0	P1
N00005 CHECK LOC/GS	3V 07 0.0	P1
N00006 CHECK MKR BGN OM	5U 01 0.0	P1 5V 01 2.1
N00007 BEGIN HOLDING LEG, ON RADIAL, AT FIX	3N 10 4.2	P1
N00008 END HOLDING LEG, AT TIME	3N 01 0.0	P1 3N 10 2.2
N00009 BEGIN HOLDING LEG, OFF RADIAL, AFTER TURN	5D 01 0.0	P1 3N 10 2.0
N00010 SCAN ENROUTE CHART	8R 01 0.0	P1
N00011 SCAN APP. PLATE	8R 07 0.0	P1
N00012 HOLD CHART #1	8R 08 0.0	P1
N00013 HOLD CHART #2	8R 08 0.0	P2
NR0001 TUNE NAV #1 L.KNOB	5U 28 0.0	P1 5U 25 0.0
NR0002 CHECK NAV #1 IDENT	1T 07 0.0	P1 1T 31 2.8
	8R 03 2.8	P1 1T 07 5.8
NR0003 ADJ. #1 OBS	5U 13 0.0	P1 5U 10 0.0
	5U 01 0.0	P3
NR0004 TUNE NAV #2 R.KNOB	5V 19 0.0	P1 5V 16 0.0
NR0005 CHECK NAV #2 IDENT	1T 10 0.0	P1 1T 31 2.8
	8R 03 2.8	P1 1T 10 5.8
NR0006 ADJ. #2 OBS	5V 07 0.0	P1 5V 04 0.0
	5V 01 0.0	P3
NR0007 TUNE ADF	5D 13 0.0	P2 5D 16 0.0
NR0008 CHECK ADF IDENT	1T 13 0.0	P1 1T 31 2.8
	8R 03 2.8	P1 1T 13 5.8
S00001 SCAN CHECKLIST	8R 10 0.0	P1
S00002 CHECK ENG. INST. AND DG PRECESSION	7F 10 0.0 7F 16 5.2	P1 7F 04 2.6 P1 7F 01 7.8
EVENT1 TAKEOFF RUNWAY 9	5K 01 10.0	P1 5D 01 12.6
EVENT2 TURN LEFT TO INT. R-360 ATL VORTAC		
EVENT3 LEVEL OFF AT 3500FT.		
EVENT4 INT. R-360 ATL		
EVENT5 CROSS TROYS INT AND ENTER HOLDING PATTERN		
EVENT6 EXIT PATTERN WITH VECTORS TO ILS		
EVENT7 RECEIVE VECTOR TO 180 DEG. BASE LEG		
EVENT8 RECEIVE VECTOR TO 120 DEG. TO INT. ILS RWY 8		
EVENT9 INT. ILS RWY 8		
EVENT10 INT. G/S, BEGIN DESCENT, CROSS LOW		
EVENT11 CROSS MM, EST. VISUAL CONTACT WITH RUNWAY		
EVENT12 CROSS RWY8 THRESHOLD		

(h) Concluded.

Figure 22.- continued

TASKS						
1A	01 MOVE AUD. PNL. HIKE SWITCH	1	2.5	40	100	10
1A	04 ADJ. COM #1 VOL.	1	2.6	20	100	10
1A	07 MOVE COM #1 ON/OFF SWITCH	1	2.5	20	100	10
1A	10 TUNE COM #1	1	5.0	30	100	10
		2	3.0	20	100	10
		3	2.5	20	100	10
1A	13 SCAN COM #1 FREQ.	1	5.0	70		10
		2	5.0	80		10
		3	2.5	80		10
		4	1.4	100		10
10	01 SCAN COM #2 FREQ.	1	5.0	70		10
		2	3.0	80		10
		3	1.4	100		10
10	04 ADJ. COM #2 VOL.	1	2.6	20	100	10
10	07 MOVE COM #2 ON/OFF SWITCH	1	2.5	20	100	10
10	10 TUNE COM #2	1	5.0	30	100	10
		2	3.0	20	100	10
1N	01 SCAN TRANSPONDER MONITOR LIGHT	1	2.6	100		10
1N	04 MOVE TRANSPONDER ON/OFF SWITCH	1	2.5	20	100	10
1N	07 PUSH TRANSPONDER TEST	1	2.5	20	100	10
1N	10 PUSH TRANSPONDER IDENT	1	2.3	20	100	10
1N	13 MOVE TRANSPONDER	1	2.5	20	100	10
MODE SWITCH						
1N	16 CHANGE TRANS. CODE	1	0.6	30	100	10
		2	6.7	30	100	10
		3	4.0	30	100	10
		4	3.0	20	100	10
1N	19 SCAN TRANS. CODE	1	0.6	70		10
		2	6.7	70		10
		3	4.0	70		10
		4	3.0	80		10
1N	22 SCAN TRANS. CODE	1	1.4	100		10
1P	01 PICK UP MICROPHONE	1	2.0	50	100	10
1P	04 RETURN MICROPHONE	1	2.0	50	100	10
1P	07 MAKE RADIO TRANS.	1	2.0	100		10
		2	2.5	100		10
		3	3.0	100		10
		4	4.0	100		10
1P	10 MAKE RADIO TRANS.	1	4.5	100		10
		2	5.0	100		10
		3	5.5	100		10
		4	6.0	100		10
1P	13 MAKE RADIO TRANS.	1	7.0	100		10
		2	7.5	100		10
		3	8.5	100		10
1P	16 HOLD MICROPHONE	1	1.0	100		10
		2	2.0	100		10
		3	6.0	100		10
		4	7.0	100		10
1P	19 HOLD MICROPHONE	1	7.5	100		10
		2	8.5	100		10
1T	01 MOVE AUD. PNL. #1COM SWITCH	1	2.8	40	100	10
1T	04 MOVE AUD. PNL. #2COM SWITCH	1	2.8	40	100	10
1T	07 MOVE AUD. PNL. #1NAV SWITCH	1	2.8	40	100	10
1T	10 MOVE AUD. PNL. #2NAV SWITCH	1	2.8	40	100	10
1T	13 MOVE AUD. PNL. ADF SWITCH	1	2.8	40	100	10
1T	16 MOVE AUD. PNL. ONE SWITCH	1	2.8	40	100	10
1T	19 MOVE AUD. PNL. MKR RCN SWITCH	1	2.8	40	100	10
1T	22 NON. RADIO TRANS.	1	2.0			10 100
		2	2.5			10 100
		3	3.0			10 100
		4	3.5			10 100
1T	25 NON. RADIO TRANS.	1	4.0			10 100
		2	4.5			10 100
		3	5.0			10 100
		4	5.5			10 100
1T	28 NON. RADIO TRANS.	1	6.0			10 100
		2	7.0			10 100
		3	7.5			10 100
		4	8.5			10 100
1T	31 NON. IDENT.	1	3.0			10 100

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(c) Task data.
Figure 22.- continued.

3A	01	SCAN P AIRSPEED IND.	1	1.0	100				10	
		SIT 2 FOR TAKEOFF	2	10.0	20				10	
3A	04	SCAN CP AIRSPEED IND	1	1.6	100				10	
3H	01	SCAN ALTIMETER	1	1.0	100				10	
		USE SIT 2 WITH	2	3.0	10				10	
		3H0071 AND 3H0042								
3H	04	SCAN ALTIMETER	1	2.2	100				10	
		PRESSURE WINDOW	2	3.0	80				10	
		USE SIT 2 WITH								
		3H0012 AND 3H0071								
3H	07	SET ALTIMETER	1	3.0	10	100			10	
		USE WITH 3H0012								
		AND 3H0042								
3L	01	SCAN VERTICAL SPEED	1	2.2	100				10	
3N	01	SCAN CLOCK	1	2.2	100				10	
			2	3.0	90				10	3N0071
3N	04	WIND CLOCK	1	7.0	10	100			10	
3N	07	SET CLOCK	1	3.0	10	100			10	3N0012
3N	10	START/STOP/RESET	1	1.5	90	100			10	
		STOPWATCH SIT 2	2	2.1	80	100			10	
		FOR STOP AND RESET								
3P	01	SCAN NEEDLE/BALL	1	1.2	100				10	
3R	01	SCAN P ATTITUDE IND.	1	1.0	100				10	
			2	3.0	90				10	3R0071
			3	4.0	100				10	4A0011
3R	04	SCAN CP ATTITUDE IND	1	1.6	100				10	
			2	3.5	90				10	3R0101
3R	07	SET P ATT. IND.	1	3.0	10	100			10	3R0012
		PITCH TRIM								
3R	10	SET CP ATT. IND.	1	3.5	10	100			10	3R0042
		PITCH TRIM								
3U	01	SCAN O.A.T. GAGE	1	2.8	100				10	
3V	01	SCAN MKR BCN AIRWAYS	1	0.5	100				10	50
3V	04	SCAN MKR BCN HM	1	0.5	100				10	50
3V	07	SCAN MKR BCN OM	1	0.5	100				10	50
3V	10	SCAN CP MKR BCN ARYS	1	1.2	100				10	50
3V	13	SCAN CP MKR BCN HM	1	1.3	100				10	50
3V	16	SCAN CP MKR BCN OM	1	1.3	100				10	50
3V	19	MOVE MKR BCN SWITCH	1	2.9	20	100			10	
4A	01	MOVE CONTROLS	1	4.0		100	25	25	10	3R0013
		TO ENTER/EXIT TURN								
4A	04	MOVE CONTROLS	1	4.0		100	25	25	10	3R0013
		TO START/STOP								
		CLIMB/DESCENT								
4A	07	MOVE CONTROLS	1	1.0		25	25	25	10	
		FOR MANUAL CONTROL	2	2.0		25	25	25	10	
			3	3.0		25	25	25	10	
			4	4.0		25	25	25	10	
4A	10	MOVE CONTROLS	1	5.0		25	25	25	10	
		FOR MANUAL CONTROL	2	10.0		25	25	25	10	
			3	15.0		25	25	25	10	
			4	20.0		25	25	25	10	
4A	16	TRACK RWY CENTERLINE	1	2.6	50	25	25	25	10	
		ON GROUND	2	10.0	50	25	100	25	25	10
4B	01	MOVE LEFT PROP.	1	2.6		20	100		10	7F0012
		CONTROL	2	2.6		10	50		10	7F0012
4B	04	MOVE RIGHT PROP.	1	2.6		20	100		10	7F0012
		CONTROL	2	2.6		10	50		10	7F0012
4B	07	MOVE LEFT THROTTLE	1	2.6		20	100		10	
			2	2.6		20	50		10	
			3	2.6			100		10	
4B	10	MOVE RIGHT THROTTLE	1	2.6		20	100		10	
			2	2.6		20	50		10	
4B	13	MOVE LEFT MIXTURE	1	2.6		20	100		10	
			2	2.6		20	50		10	
4B	16	MOVE RIGHT MIXTURE	1	2.6		20	100		10	
			2	2.6		20	50		10	
4B	19	SET POWER LEVER	1	3.0		10	100		10	
		FRICTION								
4D	01	SCAN GEAR UP LIGHT	1	1.1	100				10	
4D	04	SCAN NG DOWN LIGHT	1	1.1	100				10	
4D	07	SCAN L. MAIN GEAR	1	1.1	100				10	
		DOWN LIGHT								
4D	10	SCAN R. MAIN GEAR	1	1.1	100				10	
		DOWN LIGHT								
4D	13	MOVE LON. GEAR LEVER	1	2.9	10	100			10	
4E	01	SCAN FLAP POS. IND.	1	2.4	100				10	
			2	2.5	90				10	4E0041
4E	04	MOVE FLAP SWITCH	1	2.5	10	100			10	
4G	01	SCAN ROLL TRIM POS.	1	2.0	100				10	
			2	3.7	10				10	4G0161
4G	04	SCAN PITCH TRIM IND.	1	2.4	100				10	
			2	3.7	80				10	4G0131
4G	07	SCAN YAW TRIM IND.	1	2.4	100				10	
			2	3.7	80				10	4G0101

(c) Continued.

Figure 22.- continued.

4G	10	ADJ. YAW TRIM	1	3.7	100	10	4G0072
4G	13	ADJ. PITCH TRIM	1	3.7	100	10	4G0042
4G	16	ADJ. ROLL TRIM	1	3.7	100	10	4G0012
5D	01	SCAN P RMI	1	2.0	100	10	
5D	04	SCAN CP RMI	1	2.0	100	10	
5D	07	MOVE ADF ON/OFF	1	2.5	20	100	10

SWITCH							
5D	10	ADJ. ADF VOL.	1	2.6	20	100	10
5D	13	TUNE ADF	1	6.6	30	100	10
			2	5.0	30	100	10
			3	3.0	20	100	10
5D	14	SCAN P #1 RMI SWITCH	1	0.5	100	10	5D0161
5D	15	SCAN P ADF ARROW	1	2.0	100	10	5D0162
5D	16	SCAN ADF FREQ.	1	6.6	70	10	5D0131
			2	5.0	70	10	5D0132
			3	3.0	80	10	5D0133
			4	1.4	100	10	
5D	19	MOVE P #1 RMI SWITCH	1	2.4	20	100	10
5D	22	MOVE P #2 RMI SWITCH	1	2.4	20	100	10
5D	25	MOVE CP#1 RMI SWITCH	1	2.7	20	100	10
5D	28	MOVE CP#2 RMI SWITCH	1	2.7	20	100	10
5K	01	SCAN MAG. COMPASS	1	2.6	100	10	
5P	01	SCAN DME	1	1.4	100	10	
			2	2.7	80	10	5P0041
5P	04	MOVE DME SWITCH	1	2.7	20	100	10
5U	01	SCAN P #1 VOR/LOC GS	1	2.1	100	10	
		USE SIT 243 WITH	2	3.0	80	10	5U0102
		5U0131	3	3.0	10	10	5U0103
5U	04	SCAN CP VOR/LOC GS	1	2.6	100	10	
		USE SIT 243 WITH	2	3.1	80	10	5U0072
		5U0161	3	3.1	10	10	5U0073
5U	07	SCAN CP VOP	1	2.6	100	10	
		AZIMUTH CARD WINDOW	2	3.1	10	10	5U0042
		USE SIT 243 WITH	3	3.1	80	10	5U0043
		5U0161					
5U	10	SCAN P #1 VOR	1	2.2	100	10	
		AZIMUTH CARD WINDOW	2	3.0	10	10	5U0012
		USE SIT 243 WITH	3	3.0	80	10	5U0013
		5U0131					
5U	13	SET P #1 VOR OBS	1	3.0	10	100	10
		USE WITH 5U0012 AND					
		5U0102 OR 5U0013					
		AND 5U0103					
5U	16	SET CP VOR OBS	1	3.1	10	100	10
		USE WITH 5U0042 AND					
		5U0072 OR 5U0043					
		AND 5U0072					
5U	19	ADJ. NAV #1 VOL.	1	2.6	20	100	10
5U	22	MOVE NAV #1 ON/OFF	1	2.5	20	100	10
		SWITCH					
5U	25	TUNE NAV #1	1	5.0	30	100	10
			2	3.0	20	100	10
5U	28	SCAN NAV #1 FREQ.	1	5.0	70	10	5U0281
			2	3.0	80	10	5U0282
			3	1.4	100	10	5U0251
							5U0252
5V	01	SCAN P #2 VOP/LOC	1	2.1	100	10	
		USE SIT 243 WITH	2	3.0	80	10	5V0042
		5V0071	3	3.0	10	10	5V0043
5V	04	SCAN P #2 VOR	1	2.2	100	10	
		AZIMUTH CARD WINDOW	2	3.0	10	10	5V0012
		USE SIT 243 WITH	3	3.0	80	10	5V0013
		5V0071					
5V	07	SET P #2 VOR OBS	1	3.0	10	100	10
		USE WITH 5V0012 AND					
		5V0042 OR 5V0013					
		AND 5V0043					
5V	10	ADJ. NAV #2 VOL.	1	2.6	20	100	10
5V	13	MOVE NAV #2 ON/OFF	1	2.5	20	100	10
		SWITCH					
5V	16	TUNE NAV #2	1	5.0	30	100	10
			2	3.0	20	100	10
5V	19	SCAN NAV #2 FREQ.	1	5.0	70	10	5V0191
			2	3.0	80	10	5V0192
			3	1.4	100	10	5V0161
							5V0162
7B	01	SCAN AMMETER #1	1	2.2	100	10	
7B	04	SCAN AMMETER #2	1	2.3	100	10	
7B	07	MOVE MASTER SWITCH	1	2.9	10	100	10
7C	01	SCAN FUEL PRESSURE	1	2.4	100	10	
7C	04	SCAN FUEL GAGE #1	1	2.4	100	10	
7C	07	SCAN FUEL GAGE #2	1	2.4	100	10	
7C	10	MOVE LEFT FUEL BOOST	1	2.6	10	100	10
		SWITCH					
7C	13	MOVE RIGHT FUEL	1	2.6	10	100	10
		BOOST SWITCH					

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(c) Continued
Figure 22.- continued.

7F	01	SCAN TACHOMETER	1	2.2	100			10
		USE SIT 2 WITH	2	2.6	80			10
		480011 OR 480041 OR						
		480012 AND 480042						
7F	04	SCAN OIL PRESSURE #1	1	2.6	100			10
7F	07	SCAN OIL PRESSURE #2	1	2.8	100			10
7F	10	SCAN OIL TEMP. #1	1	2.6	100			10
7F	13	SCAN OIL TEMP. #2	1	2.8	100			10
7F	16	SCAN CYL. TEMP. #1	1	2.6	100			10
7F	19	SCAN CYL. TEMP. #2	1	2.6	100			10
7F	22	ADJ. LEFT COWL FLAP	1	3.5	40	100		10
7F	25	ADJ. RIGHT COWL FLAP	1	3.5	40	100		10
7G	01	MOVE STROBE LIGHT	1	2.7	20	100		10
		SWITCH						
7G	04	MOVE NAV. LIGHT	1	2.7	20	100		10
		SWITCH						
7G	07	MOVE ROT. BCN.	1	2.7	20	100		10
		LIGHT SWITCH						
7G	10	MOVE MAP LIGHT	1	2.7	20	100		10
		SWITCH						
7G	13	MOVE TAXI LIGHT	1	2.7	20	100		10
		SWITCH						
7G	16	MOVE LEFT LDG.	1	2.7	20	100		10
		LIGHT SWITCH						
7G	19	MOVE RIGHT LDG.	1	2.7	20	100		10
		LIGHT SWITCH						
7G	22	MOVE #1 PNL. LIGHTS	1	2.8	20	100		10
7G	25	MOVE #2 PNL. LIGHTS	1	2.8	20	100		10
		SWITCH						
7G	28	MOVE RADIO LIGHTS	1	2.8	20	100		10
		SWITCH						
7G	31	MOVE RED/WHITE	1	2.6	20	100		10
		SWITCH						
7M	01	MOVE LEFT MAGNETO	1	2.9	20	100		10
		SWITCH						
7M	04	MOVE RIGHT MAGNETO	1	2.9	20	100		10
		SWITCH						
7V	01	SCAN VACUUM GAGE	1	2.6	100			10
8A	01	SCAN OUTSIDE	1	1.5	100			10
		AIRCRAFT	2	2.0	100			10
			3	2.5	100			10
			4	3.0	100			10
8A	04	SCAN OUTSIDE	1	3.5	100			10
		AIRCRAFT	2	4.0	100			10
			3	4.5	100			10
			4	5.0	100			10
8B	01	SCAN ENROUTE CHART	1	2.0	100	10	50	10
			2	3.0	100	10	50	10
			3	4.0	100	10	50	10
			4	5.0	100	10	50	10
8B	03	SCAN IDENT ON CHART	1	3.0	100	10	50	10
8B	04	FIND APP. PLATE	1	4.0	100	10	90	10
8B	07	SCAN APP. PLATE	1	2.0	100		30	10
			2	3.0	100		30	10
			3	4.0	100		30	10
			4	5.0	100		30	10
8B	08	HOLD CHART	1	1.0			50	10
			2	2.0			50	10
8B	10	SCAN CHECKLIST	1	2.0	100		30	10
			2	3.0	100		30	10
8B	13	COPY CLEARANCE	1	2.5	100	10	100	10
			2	3.0	100	10	100	10
			3	3.5	100	10	100	10
			4	4.0	100	10	100	10
8B	16	COPY CLEARANCE	1	4.5	100	10	100	10
			2	5.0	100	10	100	10
			3	5.5	100	10	100	10
			4	6.0	100	10	100	10

170311

(c) Concluded.

Figure 22.- continued

SUBSYSTEMS
1A COM #1
1B COM #2
1N TRANSPONDER
1P VOICE
1T AUDIO
3A AIRSPEED INDICATOR
3H ALTIMETER
3L VERTICAL SPEED INDICATOR
3N CLOCK
3P NEEDLE/BALL
3R ATTITUDE INDICATOR
3U OAT INDICATOR
3V MARKER BEACON
4A PRIMARY ATTITUDE CONTROL
4B PROPULSION CONTROL
4D LANDING GEAR
4E FLAPS
4G TRIM
5D ADF/RMI
5K MAGNETIC COMPASS
5P DME
5U NAV #1
5V NAV #2
7B ELECTRICAL
7C FUEL
7F ENGINE
7G LIGHTS
7M ENGINE STARTING
7V VACUUM
8A VISION
8B CHARTS/CHECKLISTS

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(d) Subsystem data.
Figure 22.- concluded.